# JOURNAL OF GAS LIGHTING, WATER SUPPLY, &c.

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## EDITORIAL NOTES—GAS, &c.

### The Institution Meeting in Dublin.

FOR the second time the capital city of Ireland has given greeting to the premier gas organization of the British Isles. But a generation of gas engineers and managers has passed since the first meeting; and among the 300 odd gas engineers and managers who assembled in Dublin last week under the presidency of Mr. Charles Hunt, M.Inst.C.E., there were less than half-a-dozen who could lay claim to having been present at the meeting 36 years ago. But in the interval Dublin has lost none of its traditional generosity to strangers within its gates; for the degree of the warmth of reception was vastly more than that produced by any mere observance of an obligation. "*Céad Mile Fáilte.*" The visitors learned that the sentiment is something more than a piece of superficiality or lip utterance among their Irish kinsmen. On all sides, their welcome could be both seen and felt—from the time the Lord Mayor (Mr. Councillor Nannetti, M.P.) tendered them welcome until the final scene of the memorable gathering. The Alliance and Dublin Consumers' Gas Company (represented mainly throughout the week by Alderman W. F. Cotton, D.L., J.P., and Mr. Francis T. Cotton, the Secretary and General Manager, whose services in making the arrangements for the meeting and in looking after their execution were unceasing, and could not possibly have been exceeded) were the perfection of hosts. The Royal Dublin Society, in lending their splendid lecture theatre for the meetings, contributed in no small measure to their success; and the amenities of the visit were greatly enhanced by the privileges liberally afforded by the Lord Mayor, the Tramways Company, and the Executive Council of the Irish International Exhibition. It was a notable combination of interest and warm-heartedness, to which we desire to subscribe with the President, the Council, and the members our fullest praise and acknowledgment.

The meeting must also be stamped as unique in respect of the number of visitors from abroad. The gas professions of three neighbouring countries—France, Germany, and Denmark—as well as of America and Japan, were represented; and what is also of unusual interest, two of the papers were contributed in person by American authors. Last year, too, a paper was read by Herr E. Körting, of Berlin; and its merit gained for him the London gold medal of the Institution. This personal and technical intercommunication between the gas professions of different nations is a feature that we hope the successful experience on this occasion will further encourage. The friendship so engendered cannot fail both in bearing good technically, and in broadening sympathies in all efforts to promote the welfare of the gas industry both at home and abroad.

In all respects last week's meeting was a magnificent success from beginning to end; and the record will be of inestimable value to the whole industry. Every year now finds the industry with fewer "sleepy hollows" in its administration; and if the recent proceedings are not sufficiently potent to produce animation in those remaining, then all we can say is that the somnolence is deeper than we ever suspected. From the President's address, through the papers, if we except those treating of the connection between coke-oven practice and the manufacturing interests of the gas industry, theme compassed politic commercialism, and improvement in the means of utilization and service, to which the lecture by Professor Vivian B. Lewes on "The Use of Gas from a Hygienic Standpoint" supplied an illuminating supplement. We can only urge with all sincerity that everywhere the proceedings should be read, marked, learned, and inwardly digested; and then advantage must accrue.

There were two or three points apart from the ordinary proceedings to which attention should also be specially directed. The Council have been requested to consider, at the instance of Mr. C. Stafford Ellery, whether anything can be done to lighten the additional burden of insurance that must fall upon gas undertakings, in common with other industrial concerns, under the new Workmen's Compensation Act, which comes into operation on July 1. The importance of the matter is great; but the Council have been given short notice in which to thoroughly inquire into the question and report before gas undertakings, for their own protection, must take some individual action. But better late than never, as, by some combined action, the Insurance Offices may be induced to see that it will be to their interest to accept a somewhat more moderate view as to the risk entailed by gas-works operations, and reduce their terms. Another question—raised in connection with Mr. F. W. Goodenough's paper on "The Sale of Gas"—to which the Council may give their attention, is that of advertising the uses of gas in periodicals of general circulation, through a fund specially subscribed by gas undertakings. The difficulty we foresee is that subscription to such a fund would not be general, though the amount required for the purpose would be comparatively insignificant from individual undertakings. Mr. Goodenough, of course, regards the matter from the outlook of the Gaslight and Coke Company, which is not that of Provincial Companies who serve cities and towns in which the local papers have a more general circulation than in London, where interests are largely divided between suburban home life and commercial and professional occupation frequently some miles away, and where, in consequence, concern is largely divorced from local affairs and district newspapers. At the same time, we heartily support any effort to keep the merits and uses of gas well before the public, though we fear in this instance the realization of general countenance. One other incidental point was the instruction from the members to the delegates of the Institution to the next meeting of the International Committee on Photometry to support the 10-candle pentane lamp and the Metropolitan argand No. 2 burner as the recognized standards up to and including 20-candle gas.

With our congratulations to the President and the Council on the eminent success of the meeting, we link our best wishes to the incoming President, Mr. W. Doig Gibb, for such a year of office as his enthusiastic nature would most desire. His elevation to the chair puts Mr. Thomas Glover in the position of Senior Vice-President. Mr. James W. Helps has relinquished the Honorary Secretaryship to also take position in the line of successors to the highest dignity the members can bestow. Mr. S. Y. Shoubridge has undertaken the by no means easy task of following Mr. Helps in the Honorary Secretaryship; and we heartily wish him every success.

### The Presidential Address.

IT must have been the common thought long before the President had concluded his Inaugural Address, that there was no need for the semi-apology, or the prayer for sympathy with which he began it. As the years have moved, so has the gas industry; and though this is the seventh exercise—truly a brilliant testimony to professional esteem—in presidential addresses in this one quarter, the time that has elapsed between each has been sufficient to produce fresh themes around which the utterances of one whose capacity, view, and position are as broad and unrestrained as those of the President, can build new interest and stimulate to fresh conception. Who can review so well the years as he who has lived in them? and who, being sentient, can apply the lessons so well of those years to the reading of the signs of the times? In the address we have retrospection; and we have introspection. The one applied to the other shows how near we have been deep in the past to things that are merely present-day realizations. Though they have long been almost within grasp, the hand has been powerless to close upon them, and take of their benefits; or, in the course of events to an expected issue, some extraneous

circumstance has forced its way to stop the rapidity of evolution. We see when things are actualities that there has been past loss and waste; but the blame cannot always be attached to remissness in human endeavour. Human endeavour is not infallible; and its roots are not so deeply planted and far-reaching that they are self-supporting, and can do without the application of some external stimulant. Events that have in later years interposed themselves in the previous even tenour of the way of the gas industry have helped to show where faults and weaknesses exist, and have acted as excitants to amendment, to improvement, and to advance. They have brought needs into prominence; and they have directed to the ends necessary to the maintenance of vitality. But of these there is not yet such complete recognition as could be wished, though their transition from the adumbrate state to material form has been rapid.

Twenty-six years ago, the President reminds us, the final meeting of the British Association of Gas Managers was held, and over that, as it happened, he had the honour to preside. There was then, he also tells us, a "keen desire" for a wider and, if possible, a higher sphere of usefulness than was believed to be attainable under the older and more primitive organization. But the future student of the history of the British gas industry reading the Presidential Address will have some difficulty in reconciling the "keen desire" for a higher sphere of usefulness with the statement that, concurrently with that desire, an appeal for funds for investigation into the problems then facing the industry only resulted in less than one-third the amount of the insignificant £600 or so that the Council have realized from a similar appeal within the past fifteen months, and the same student will have some difficulty, too, in reconciling the "keen desire" with the lapse of more than a quarter of a century before any definite work has been entered upon. The fulfilment of the "keen desire" to greater usefulness in unravelling the higher problems of the industry has been a slow growth, and now will be stunted if the holders of the purse strings cannot be incited to further loosen them. But we have sympathy and part in the President's sanguine feeling that there will emerge from the work now really in hand, in which science and practice are collaborating, such useful result that assistance in the future cannot be refused. It is, as he says, "incumbent "upon us to do all in our power, not only collectively but "individually, to encourage and promote the application of "scientific methods to our daily work as the surest means "by which real progress can be effected." The President's admonitory suggestion, that nothing should be done to discourage individual work, may be taken to be addressed rather to gas administrators than to the working individuals themselves. It must not be taken by the former that any collective work to which they may contribute should supplant individual effort, for that would embarrass progress more than the retention (unassisted by collective work) of the present conditions. Collective work, in itself, cannot possibly discourage individual work, where there is will and capacity. And individual conception and work always remain the source of progress; collective work its necessary aiding supplement.

Statistics, according to the way in which they are presented, can be made either interesting or dry as dust. The President does not indulge in many figures; but those he does quote have an interest. If the cited totals of the consumption of gas in the districts of statutory undertakings and of the numbers of consumers for the years 1882 and 1905 are examined, it is found that (although the President does not point it out as a lesson of the figures) that the average consumption per consumer was in 1905 rather above that of the year 1882. This, in view of those average-diminishing factors incandescent burners and prepayment meters, is a matter of considerable interest; and it indicates the important bearing that cooking, industrial use, and increased lighting requirements have had upon the fortunes of the gas industry. The incandescent burner has, in fact, endowed the industry with such liberty that it has never before possessed, and given it opportunity in the fuel branch of business of which it would be little short of suicidal not to take complete advantage. Fuel gas for lighting, heating, cooking, power, and industrial use! That is the consolidated objective of the industry; and we must not lose sight of it. The President is, technically and commercially, an out-and-out progressive, and we know that the "if" preceding the words "the gas industry is to emerge from the present "transition state as a fuel-gas supply industry" is merely a guard against the charge of dogmatism in giving expression to his personal conviction. So regarding the future of the gas industry, he urges the importance of "cheap, simple, "and effective appliances," that shall render high duty on more economical lines. While research is proceeding for the purpose of taking full advantage in manufacture of the relief from the double disadvantage of high illuminating power and excessive purification, we have here open a utilitarian line of work in connection with the means of using gas for heating that can be conducted simultaneously and with benefit. The manufacturers of heating appliances have gone as far and as fast as practical experience has enabled them to do; and now we look for a quickening of the pace and substantial improvement as the result of the research work the Institution are taking in hand, in conjunction with the physico-chemical professors of Leeds University. And may we not hope that, through the Society of British Gas Industries (with whom in various matters the Council of the Institution have already had some friendly conferences), the co-operation of the stove manufacturers may be brought to bear on the investigation, also by conference.

The recent legislation to which the President referred as having removed restriction, and helped forward by long stride progress to the destined goal of the industry, has given spur to exploration into carbonizing methods; and here we have the President at his best. He takes no high flights into theory, but treats of his subject with that direction which comes from long, studious, and practical experience. Few —and the few will only be those who still hold the views that are pronounced by the majority of gas practitioners as obsolete—will be prepared to differ from him in his presentment of the *rationale* of good carbonizing. As to the future greater productiveness of carbonization, he is an optimist; and the results of research so far encourages a fulness of that very desirable factor in all progressive effort. His beliefs as to the present, what is possible, and what should be, are many. He believes in getting as much as is economically possible from every ton of coal carbonized; and that the attainment of this end cannot be looked for from the plant in the generality of works. He believes, too, that a high yield of residuals is not inconsistent with a high yield of gas; and that it is only by unsuitable carbonizing arrangements that the two are divorced. Moreover, he declares that it would not be far from true if he asserted that a higher yield of gas than is usually obtained does not necessarily affect illuminating power; and that this indicates clearly the existence of a further reserve to be drawn upon for the production of low-grade gas by the application of suitable methods of manufacture. The results that have of late been published in our columns from the working of vertical retorts lend substantial support to the President's views. While high yields of gas, without unduly depressing illuminating power and the volume of marketable residuals, have been realized, there are the accompanying advantages of immunity from stopped ascension-pipes and naphthalene deposits; and relief from these disturbances of excellence in production and service must contribute to good working and the saving of labour expenses. The alternative methods of avoiding these difficulties are by rapidly cooling the gas immediately on leaving the retorts, or (as proposed by Herr W. Feld in his system of working, for which such high hopes are entertained) by keeping the gas at the temperature at which it leaves the retorts until it is subjected to a washing process. In the continuous system of carbonization in vertical retorts, in which there is no exposure of the gas (after it is evolved from the coal) to excessive radiant heat, and in which it has, as a matter of fact, to pass through the uncarbonized portion of the charge at the top of the retort, it may be assumed that a lowering of temperature actually commences before the gas leaves the retorts. As we recently stated, "the reason attributed by "Messrs. Woodall and Duckham for there being neither "naphthalene nor (in measurable quantity) cyanogen present "in the gas, is that the coal is subjected to a process of "fractional decomposition—each fraction coming over at its "own critical temperature, and never having to pass through "any temperature higher than that at which it is evolved." But this is one of those points that court investigation; and that will without doubt be carefully inquired into by the Committee the Council of the Institution have appointed to examine into problems associated with carbonization. In conjunction with this question, the President still entertains some amount of admiration for recovery coke-ovens as possessing advantages in the saving of labour, and as offering to

the gas maker utility as an ally "when circumstances happen "to be favourable." That is, of course, the main consideration; but the "favourable circumstances" in this country, so far as can be seen at present, are limited to very definite areas. At the same time, we look hopefully to the coming of something between the coke oven and present gas-retort systems, whereby carbonization in larger bulk than at present may effect economy. But we must always keep an eye on the balance-sheet, lest a saving in one direction is sunk in the increased expenditure or loss in another. In this connection, the President indicated his view that the "Coalite" system has not been based on economical considerations.

The address embraced many "familiar themes," as the President described them—such as the cultivation of the friendship of ironmongers, the necessity for greater regard to ventilation on the part of architects and builders, the use of tar for roadways, co-partnership, the relative costs of electricity and gas for public lighting, taxation without representation, and so on—with the views expressed upon which, as our columns have already shown, we are in perfect accord and sympathy. The President almost invites discussion on the vexed question of the remission of the coal tax; but here we will glide as gracefully over his points as he has done over the facts that the remission of the coal tax has lost to the country a considerable amount of revenue, that the remission has not in any way benefited consumers at home or abroad, and that—however important the export coal trade is to the country, during the existence of the tax, as the Board of Trade returns irrefutably declare—exports were not in the slightest degree injured, but were continuously on the increase. The indications are that the remission of the coal tax tended to stimulate not only exports but prices; and many foreign buyers dropped nicely into the net spread for them. In the brief consideration given in the address to the question of the capital indebtedness of companies and local authorities, the President might have referred to one other matter other than conversion which tends to widen the difference in the capital per million cubic feet, and that is the inferiority of the environment and circumstances of a large proportion of the companies in comparison with the local authorities. His remarks on this head were decidedly incomplete.

Given a liberal policy, controlled by prudence, with full recognition of what everything points to as being the destiny of the gas industry, then we shall not look in vain for the reward. That is the essence of the presidential message.

## The Papers.

From the commencement of the past Institution year—that is to say, the year marked by the term of the presidency—it has been the desire of the President and the Council, in consideration of the meeting being held in Dublin, and of the Irish International Exhibition incorporating a Gas Section, that the proceedings at this meeting should incline to the commercial and utilization sides of the gas business. The desire was consummated. Two of the papers treated upon the all-important questions of business development methods and the relations between suppliers and customers, one with gas-fires, another with incandescent gas lighting, and Professor Lewes scattered to the four winds the erroneous notions of electricians (sedulously disseminated by them in the arduous task of promoting their lighting business) as to the evil effects of burning gas in rooms. One of the other papers gave up-to-date information on high-pressure distribution as practised in America; and that, too, is a subject that has reference to the improvement of service to the consumers. Of papers treating of gas-manufacturing processes, accepted or under trial, there was not one—the nearest approach being the three contributions which had for their object the revival of interest among the gas profession of this country in the question of carbonization in bulk as performed in bye-product coke-ovens. The current question of the use of tar for the improvement of roadways completed the topics before the members on this occasion. It was altogether an exceptional programme for an exceptional meeting. Owing to its length, however, most of the papers were summarized by the authors. This method of economizing time has its advantages and disadvantages, in which such advantage as there is is all on the side of time; the disadvantage on the side of the authors, through being compelled to answer criticism covered by the, in condensation, omitted parts of the text of their papers. When papers are distributed well before the meetings, those who intend to speak on any subject ought to make it a self-imposed duty to be thoroughly well grounded beforehand in the author's presentment of the subject. For ignorance of his points has a wonderful discounting effect on the economy in time purposed to be effected by abbreviation in reading. However, the discussions were full, and were sustained with vigour to the very end of the sittings—much to the gratification of the President.

There is no necessity here to talk at length round about the subjects of the papers, or to critically examine their contents, as their features are brought into full relief in the "Review" preceding our general report. But we can pay well-deserved compliment to one and all of the authors and express the hope that their contributions will bear abundant and good fruit. Commercial stimulation is still required; it is to be had in the papers by Mr. F. W. Goodenough and Mr. J. G. Tooms. The means of utilizing gas are capable of further improvement; the way is opened up, in connection with burners and fires, in the respective papers of Mr. J. H. Brearley and Mr. Harold E. Copp. The President insisted in his address that what is wanted in conjunction with low-priced gas are cheap, simple, and effective appliances. We are afraid that all the makers of these appliances have not done so much as they might have done to blend science with their practice in manufacture; and, on the other hand, gas engineers have not exercised themselves so much as they might have done in such research as Mr. Brearley and Mr. Copp have independently and respectively devoted to gas-fires and gas-burners. Independent investigation by men of such competence as gas engineers must prompt manufacturers to do all possible to suppress discovered defects and to advance efficiency, in the interests of themselves, and those of the purveyors and consumers of gas.

Concerning high-pressure distribution, the practice is not so uncommon in this country as some seem to imagine (especially for reinforcing district supplies), though we have not yet emulated American friends in impelling gas through pipes at the higher pressures advocated and used by them. There is more to be learnt yet as to the effects upon the gas of very high pressures. As Mr. H. L. Rice, of the Western United Gas and Electric Company of Aurora, in his communication to the author of the paper on this subject (Mr. R. M. Searle), says: "We do not know nearly enough yet "about the loss in candle power and heat units in com- "pressing and in transmitting high-pressure gas. There "is some loss, of course; and we know it is less with coal "gas than with water gas." But in his paper, Mr. Searle shows that observed loss (he does not tell us whether the investigation was on coal gas or carburetted water gas, or a mixture of both) in illuminating power, transmitting gas for 8 miles at 5 lbs. pressure, was 11 per cent. That is sufficient to produce pause—at any rate, in this country, where the photometer controls. The coke-oven papers present us with a variety of data and considerations that are valuable, but inconclusive. They are worth study, however; but the result will be that, until there is further investigation, the question must remain open as to whether, for gas-supply undertakings, "the game is worth the candle." Carbonization in greater bulk, however, is one of the problems before the industry; and, as Mr. Thomas Glover suggests, it is worth while ascertaining whether there is not some half-way house between bye-product coke-oven practice and that of present-day gas-manufacturing systems. Touching the question of the employment of tar for road purposes, we can only again emphasize the advice to gas makers to encourage it at the present to the utmost. The encouragement that has been so far given to road authorities to use tar has proved that the merits and economies realized by it exceed considerably the single original purpose of allaying the dust nuisance. As this experience advances, road authorities will recognize that the tar producers will be deserving of greater recompense; but let the experience advance first. This use of tar is not going to be ephemeral, but a progressive one in the future. Does anyone want a broader hint than this?

## Gas Matters at the Engineering Conference.

Thanks mainly to the efforts of Sir George Livesey, in the chair at the sitting of Section VI. of the Engineering Conference on Thursday morning last, interesting debates took place on the subjects that were introduced by Mr. W. H. Y. Webber and Mr. Charles Carpenter respectively. Naturally the meeting of the Institution of Gas Engineers had had first claims on the gas managers of the country; but a good sprinkling of London gas men, who had been prevented from

going to Dublin, was to be found in the upper library of the Institution of Civil Engineers when the proceedings of the section opened on Thursday. The Chairman's introductory remarks were by no means the least valuable contribution to the Conference. As will be seen from the report on another page, he referred to the advantages of gas as a smokeless fuel, and to the necessity of cheapening gas, in order that it might come into general use for heating. But the ever-recurring "booms" in the coal trade and the ever-increasing burden of local taxation constantly nullify the efforts of gas engineers to cheapen gas. It is, of course, to the interest of both the authorities and the public that gas undertakings should be more equitably rated, in order that gas may be sold at the lowest possible price. The Coalite flotation likewise passed under the Chairman's review; and his remarks thereon are referred to in another paragraph.

Mr. Webber had selected a comprehensive theme—viz., "The Applications of Towns Gas as a Heating Agent;" and naturally there was considerable, though somewhat discursive, discussion of various points raised by him. Mr. T. Goulden, Mr. Carpenter, and Mr. W. J. A. Butterfield all alluded to the fact that in Continental gas-works the heating value of the gas supplied is regarded to the exclusion of any criterion of illuminating power, and that the satisfactory character of a gas supply controlled by reference to calories instead of candles is conclusively proved by the phenomenally good lighting which prevails in Continental towns. Mr. Humphrey made a half-hearted attempt to champion Mond gas against towns gas, on the ground that its calorific power was more uniform and its toxic power less. It is, of course, obvious that when the preponderating components of a gas are inert diluents, there will be less apparent variation in calorific power (which is solely derived from its other constituents) and less toxicity than with a more highly concentrated fuel gas, such as towns gas. If the latter were diluted with as much nitrogen and carbonic acid as are present in Mond gas, it would have all the merit (and more) of the last-named gas in respect of uniformity of calorific power and lack of toxic quality. Mr. Thwaite made a similar plea of uniformity for blast-furnace gas and suction-producer gas; but the fallacy underlying his contention was fairly obvious. For the rest, after remarks by Mr. William King, Mr. C. E. Jones, and a few other gas men, a number of engineers, who had strayed in from other sections of the Conference, posed merely as gas consumers, and talked more or less at random.

The section was brought back to serious work again when Mr. Carpenter opened the subject of "The Distribution of Gas at Increased Pressure." His excellent summary of what the South Metropolitan Gas Company have done in this direction deserves careful reading; as do also the remarks of Mr. Martin, Mr. T. C. Lacey, and Mr. King. Unfortunately, rather too much time had been devoted to the previous paper; and the discussion of the more highly technical matter introduced by Mr. Carpenter was somewhat hastened to a close, in order that the sitting might end at the accustomed hour. The Chairman had been ably seconded in his efforts to secure a good debate on both subjects by Mr. Henry Woodall, who was acting as Honorary Secretary in this section of the Conference. The proceedings extended over rather more than three hours, and upwards of fifty engineers were present. Having regard to the meeting in Dublin, this muster is as large as could well be expected.

## Prospectus of British Coalite, Limited.

The prospectus of the British Coalite Company, Limited, has duly made its appearance; and the public has therein been invited to provide a million and a half of money for the exploitation of the "Coalite" process. The parent Company—Coalite, Limited—is to receive £55,000 in cash, which should suffice to cover the heavy costs of advertising, underwriting, &c., incurred by it, and half-a-million in deferred ordinary shares. The purchase consideration appears to have undergone a sudden diminution from £100,000 to £55,000 between the issue of the "proof" and the "final" prospectus. It is noteworthy that of the six Directors of British Coalite only one—viz., Mr. A. C. Cory-Wright, J.P.—was not a shareholder in "Coalite, Limited," according to the proof prospectus; but in the interval between its appearance and the issue of the final prospectus, Sir W. H. Bailey appears to have taken the opportunity to dispose of his holding of 300 ordinary shares in "Coalite, Limited." Other interesting facts might be gleaned from a comparison of the preliminary and the final issues of the prospectus. From both, however, it is obvious that Mr. A. C. Cory-Wright has granted his aid to the new Company only in consideration of agreements made between it and his firm, Messrs. Wm. Cory and Son, Limited, of a nature highly favourable to the latter. Messrs. Cory we gather are not only to collect and sell the whole output of Coalite in the Metropolitan and other defined areas, but are to act as sole agents for the purchase of coal within such areas. It would appear, therefore, that the new Company are bound to purchase their supply of coal entirely through one firm of coal factors for a period of twenty-one years. What consideration would not a coal merchant offer to have even one of the Metropolitan Gas Companies similarly at his mercy in respect of its purchase of coal?

## Sir George Livesey Challenges the Coalite Patents.

Those who have responded to the invitation to subscribe for ordinary shares in the British Coalite Company will learn by degrees the true import of the agreement referred to above, and the true value of the patent rights which the Company have purchased without disclosure of their specification. Their equanimity may, however, be somewhat perturbed by Sir George Livesey's remarks in his opening address to Section VI. of the Engineering Conference last Thursday. There was, he said, "nothing to prevent gas companies selling a coke that would answer the same purpose [as 'Coalite'] and what the British Coalite Company were going to do then, he did not know. He was told that, if gas companies tried to sell coke of that sort, the Company would attack them. All the better; for then they would see if the patents which had been kept a secret up to the present were worth the paper they were written on." The Gaslight and Coke Company are already advertising "Carbo," upon which we had a special article last week; and those who have invested money in the new Company should see to it that the Board take proper steps to protect their interests, and to prevent this "infringement" of the dearly bought patent rights. But they must not be surprised if such action proves the truth of Sir George Livesey's observation, and demonstrates that the "Coalite" patents are comparatively valueless.

## Mond Gas.

When making comments on the only partially disclosed "Coalite" process a few weeks ago, we incidentally instituted some comparisons between the Mond gas process and gas-works processes, and pointed out that the owners of works in South Staffordshire had not availed themselves freely of their opportunities to take a supply of Mond gas. Our observations were based on the report of the proceedings at the last general meeting of the South Staffordshire (Mond) Gas Company; and we are glad to learn, from the letter published last week from the Secretary of the Company, that the number of consumers of Mond gas in their district is now increasing, and that private suction and other gas producers are being shut down in favour of the public supply. It would be interesting to know on what terms Mond gas is supplied in these cases, and whether they will prove remunerative to the Company. We refer in an editorial article to the alleged greater uniformity of Mond gas and producer gas in respect of calorific value, as compared with towns gas. As to the reputed superior quality, it is obvious that Mond gas compares favourably with ordinary producer gas; but it must be remembered that less steam is consumed in the production of the latter. The steam consumption of the Mond gas plant should suffice for the production of tolerably good water gas, instead of a gas comparable in calorific value only with producer gas. We prefer, technically, to regard Mond gas as a half-burnt water gas. Reference to the paper by Dr. Bone and Mr. Wheeler (*ante*, p. 524) will indicate, on the other hand, in what manner the efficiency of Mond gas plant may be improved—at the expense of the output of ammonia. The Secretary to the South Staffordshire Mond Gas Company has been good enough to state the average calorific value of the gas supplied by his Company. In order to judge the technical efficiency of the process—which was the subject of our earlier remarks—it is necessary to know also the average yields of gas and of sulphate of ammonia per ton of coal.

# THE INSTITUTION OF GAS ENGINEERS.

## PROCEEDINGS AT THE FIFTH ANNUAL GENERAL MEETING,

HELD IN THE

LECTURE THEATRE OF THE ROYAL DUBLIN SOCIETY,

JUNE 18, 19, and 20, 1907.

MR. CHARLES HUNT, M.INST.C.E., OF LONDON, IN THE CHAIR.

## REVIEW OF PROCEEDINGS.

(For Full Report see p. 913.)

MEMBERS of the Institution and their friends began to arrive in Dublin on the Saturday preceding the meeting. The weather on the Sunday and Monday was delightful; and those fortunate individuals who were in a position to get thus early to the *rendezvous*, or to charming Bray, voted them as most agreeable places in which to spend a restful and enjoyable week-end. From Saturday, every fresh arriving boat at Kingstown or North Wall brought in its addition to the members who had informed the Secretary of the Institution (Mr. Walter T. Dunn) of their intention to be present at the meeting; until on Tuesday morning, when the opening sitting was to be held, there was a large and representative gathering—such a gathering, in fact, as would not have disgraced a London meeting. It was ascertained that altogether 410 railway vouchers had been issued for the meeting, about 300 of which represented members, and the remainder their lady friends and a few visitors. True, these numbers are not so considerable as they would have been had the meeting been held in London or one of the other large centres, which did not involve a sea passage. To Dublin the distance was great for the majority of the members; but there is no doubt about it that the capital of the Sister Isle greatly appreciated the visit of the Institution, and gave the members on all hands as royal a welcome as the most scrupulously courteous could have desired. The Lord Mayor (Mr. Councillor Nannetti, M.P.), the Alliance and Dublin Consumers' Gas Company (with their Chairman, Alderman Cotton, D.L., J.P., and the Secretary and General Manager, Mr. Francis T. Cotton), and the Royal Dublin Society, had taken especial care that there should be no shortcomings in giving welcome and providing comfort; and not the least of the privileges accorded to the members, of which full advantage was taken during the meeting, were the free passes on the lines of the Dublin United Tramways Company. The Irish International Exhibition, of course, was another great attraction; but everywhere welcome was evident. And Dublin courts more of this kind of thing, and the greater interest of the members of the one and same family—England, Scotland, and Wales.

On Tuesday morning the garden approaches to the excellent and well-appointed Lecture Theatre of the Royal Dublin Society, in Kildare Street, were, some time before the meeting, the scene of many reunions. Hearty greetings met one on all hands. Inside the theatre, the central seats and the balconies and galleries were fairly well filled—the upper one by a front row of ladies, who were most interested spectators of the opening proceedings, until the close of the President's Address, when their interest waned. There was a hearty reception from the benches as the President—Mr. Charles Hunt, M.Inst.C.E., of London—appeared on the stage, accompanied by the Lord Mayor, the Vice-President of the Institution (Mr. W. Doig Gibb), the Hon. Secretary (Mr. J. W. Helps), most of the members of the Council, and two or three honoured visitors, representing France and America—viz., M. Marquisan, the Treasurer of the Société Technique de l'Industrie du Gaz, Mr. R. M. Searle, of Rochester, N.Y., and Mr. Paul Schlicht, of New York. The presence of these gentlemen was greatly esteemed—in fact, in Dublin there was the nearest approach to international representation that the Institution has ever had.

### Cead Mile Failte.

Silence restored, the Lord Mayor, the Chief of the city, needed no invitation from the President or any introduction. But, in virtue of his position, he at once rose to bid the members a cordial welcome; and he did it with that depth of sincerity which is more evident in tone and expression than in the mere words used. Up to then there had been rain, with threatening interludes; but even as the Lord Mayor spoke, the sun's rays streamed through the upper windows of the theatre. The opening proceedings were altogether of a joyous character; and they put the whole meeting into a good frame of mind for the sitting. As the Chief Magistrate of the city, the Lord Mayor asked to be allowed to extend to the members of the Institution *céad mile fáilte*, including the French and the American delegates. The Lord Mayor betrayed his native humour when he suggested that he hoped the far-reaching deliberations of the members would tend to cheapen the price of gas in Dublin. His Lordship heard something from the President later in the morning as to the comparative costs of gas and electricity for street lighting; and no doubt he found in it that which will give him cause for suspicion and inquiry as to which is the cheaper illuminant. However, his words regarding the Institution and the visitors were flattering; his wish for the meeting being productive of good being very much to the point, and very graciously and heartily expressed. Well chosen were the words with which the President acknowledged the welcome of his Lordship, with whom, no doubt, he doubly ingratiated himself by saying that the sympathies of the members were with him in his desire for cheaper and impossible better gas. And the observation hit its mark by raising a general laugh, in which his Lordship joined, when the President, with the seriousness he can so well assume, said the members were there to right those who suffer wrong; and that he hoped they would be in the city long enough to effect the purpose desired. Many had not recalled the fact until the President reminded them, that the British Association of Gas Managers held their meeting in Dublin in 1871; and, as it happened, that meeting was under the presidency of Mr. Hunt's immediate predecessor at Birmingham. The President asked that those present who attended the meeting in 1871 should signify it; and only four responded. Another coincidence was that the President at that Dublin meeting made his *début* as a contributor of gas engineering papers, though he was not present to read it himself.

### Workmen's Compensation.

This happy opening to the proceedings ended, attention was turned to general matters for a few minutes. Messrs. Charles Meiklejohn and G. F. Ruggles were appointed Scrutineers, and were dispatched to examine the voting-papers. Time was saved in taking the Council's report as read; but there was one important question raised upon it, though it was not mentioned in the report. Members were reminded by Mr. C. Stafford Ellery that on the first of next month the Act which would increase employers' liability and responsibility in connection with workmen would come into operation; and the point of his remarks was as to whether the members in their collective capacity—that is to say, through the Institution—could not do something to make possible the insurance of the men on more reasonable terms than those suggested by the Insurance Offices. Mr. Ellery's remarks met with a great deal of sympathy, and were certainly very apposite. It was gratifying to hear the President describe the suggestion as an excellent one, and to promise that the Council should take the matter into their

consideration, and see whether or not anything could be done. Whatever is done will have to be done quickly.

On the last day of the sittings, a resolution was passed, on the motion of Mr. Ellery, requesting the Council to consider the question of insurance under the various Compensation Acts, and suggesting the convening of a conference of representatives of the gas undertakings interested. It was the opinion of Mr. Herbert Lees that this was a matter the District Associations could well take up, instead of burdening the Institution Council with it.

**Awards.**

It was an excellent choice that the Council had made in presenting to Herr E. Körting, of Berlin, the London Gold Medal—the highest award the Institution can bestow for contributions to its proceedings—for his paper on vertical retorts, twelve months ago. Herr Körting endeared himself to members of the Institution last year; and mention of his name by the President brought back memories, and evoked acclamation. Herr Körting, it was disappointing to hear, could not be present to personally receive the tribute to his high technical capacity; but he had deputed Mr. A. F. P. Hayman, of the Imperial Continental Gas Association, to attend and receive the medal in his name. Mr. Hayman was graceful in his apologies for Herr Körting, who, he said, had been absent from duties for a week at the meeting of the German Association of Gas and Water Engineers. He emphasized the appreciation of the medal by the recipient, who did not think that the merits of the paper deserved such high honour; and he asked, through Mr. Hayman, to be allowed to look upon it also as an act of international courtesy. Mr. Charles Carpenter received the silver medal for his paper on gas-testing; and Mr. Thomas Glover the third medal for his contribution on carbonization.

**President's Address.**

Following, the members settled down to hear the President's Address. Though he had already undergone the ordeal of delivering addresses some half-a-dozen times in the course of his professional career, we hazard the opinion that never before has Mr. Hunt risen to commence this duty attaching to the presidential office with applause of more genuine human heartiness which attests popularity than that which was the prelude to the address on this occasion. The address was published last week, and is to-day referred to in our editorial columns, so that we will not attempt to digest the contents here, or do more than indicate a few of the points which provoked special expressions of the approbation of the members. The address was marked with the composer's individuality; and it shows that as time passes Mr. Hunt's sympathies and interests (always broad) continue to broaden. His references to the Special Purposes Fund of the Institution were well received; but there was no particular animation evinced. It is to be hoped the seed scattered did not fall on stony ground. The happy phrases in which his allusion to unity was couched aroused cordial approval; and his remarks as to the stability of the industry were hailed with satisfaction. Where in the address mention was made of the Society of British Gas Industries, and of the conferences of the Council with the Executive of that Society, there was encouraging applause. The President's views as to co-operation with ironmongers in advertising and selling gas apparatus appear to be the case of the general run of the members; and in the section of the address in which the subject of gas-fires was discussed, it was agreed, by the marks of approbation, that an important matter in the development of gas heating is the proper appreciation by architects and builders of the necessities of ventilation. In treating of recent gas legislation and the influence on carbonizing results, the mention of the work of Sir George Livesey in connection with the former drew from the members an exuberant expression of their appreciation. Britons are always ready to applaud a leader—especially a leader who is a good and earnest fighter in a right cause. The address abounded with epigrammatic sentences which told in Mr. Hunt's mode of delivery, even though there were occasions when his voice, during its long exercise, did not appear so strong and penetrating as of old. Here is one such sentence: "It matters not that the battle fought was that of the London Gas Companies; the victory remains with the gas industry as a whole." The remark expressed the common view. And so we went on, with the address and views punctuated with applause the whole way through. This is not surprising, seeing the catholicity of the opinions entertained by the President on most current technical subjects which have not acquaintance or association with his rather invincible political views. When the President penned the words with reference to "Coalite" in his address, he had no knowledge of the experiments of the Gaslight and Coke Company in producing smokeless fuel, which they have branded "Carbo;" and he introduced a reference to it. There are other concerns, too, which are interested in it. Edinburgh has made a trial; and "Coalite Limited" know that the Edinburgh and Leith Gas Commissioners would be very pleased to deliver a material equal in all respects to "Coalite," at a price that would pay Edinburgh, and still yield the "Coalite" people a good profit at the prices they hope to command, without going to the expense of putting up works for the production of the quantity offered. Nor was the President aware that the prospectus of the British Coalite Company, Limited, would be out that very morning with a capital of £2,000,000. The presidential observations upon the engineering trades agreement, whereby it is hoped to avoid for the future friction between employers and employees, were much to the point; and the hope that "so excellent an example will be generally followed" received the unmistakable endorsement of the practical and right-thinking men present, who realize with the President that "strikes are disastrous alike to victors and to vanquished." The Lord Mayor of Dublin appeared to be in a very reflective mood while the President was holding forth, in a most acceptable way to the members, on the subjects of the relative cost of electricity and gas for street lighting and of taxation without representation, in the course of which Mr. Hunt introduced some new facts which had come to his knowledge as to the small percentage that rates represented on profits in ordinary trades to the percentage in the case of gas companies. He pointed here a very common grievance in the gas industry.

There were many fitting things done at this meeting; and one of them was that it fell to the President of the Irish Association—Mr. T. Reid, of Ballina—to propose the thanks of the members to the President for his "illuminating address." He discharged the duty with dignity and feeling. It fell to Mr. Henry Woodall—one of Mr. Hunt's professional compeers of long standing—to second the vote; and he did it as he knows well how to do such things, by saying the right thing in the right place and to the point. There was an exchange of courtesies between these two representatives of gas engineering and managerial work of long years since—Mr. Woodall asserting that the President had not changed this last quarter of a century, and the President averring that his friend looked as young as ever.

There was nothing now standing in the way of the reading of the papers, and there was time, by prolonging the sitting a little beyond the hour appointed for its termination, to take two—those by Mr. F. W. Goodenough, of the Gaslight and Coke Company, and Mr. J. G. Tooms, of Waterford. Being on cognate subjects, they were discussed together; and time was saved by Mr. Goodenough summarizing his paper.

**Golden Rules and Accepted Truths.**

If Mr. Goodenough traversed in his paper over much that is accepted truth and the practised line of action in the gas industry, his excuse must be that his subject—"The Sale of Gas"—is one in connection with which any incompleteness of treatment might have implied neglect of common principles of conduct in the head of the gas sales department of the great Gaslight and Coke Company. In his discussion of elementary commercial principles, for example, he sets out certain things which the commonsense of every gas engineer and manager must tell him are of the proprieties to be observed in the conduct of business, and no gas engineer or manager would be prepared to confess that he is in any way negligent of them. But there are gas managers and gas managers; and it may be that in a few odd cases it is as essential to impress the necessity of straightforward, considerate, and courteous action in their dealings as to inculcate those principles among the staff and workmen who directly or indirectly come in contact with the consumers. It was written the other day of a certain admiral prince, and of his methods of dealing with his officers and men: "It is surprising what a large part is played in the Navy by sheer force of personality, by kindness allied with firmness, by encouragement reinforced by example." In these words, there is food for reflection as to the proper training of a commercial staff; and, in his paper, Mr. Goodenough shows how his large experience in London

has impressed him more and more that that is the only one and proper way of getting around a chief officer a staff whose modes of action and qualifications will serve the best interests of the concern.

As an exponent of the business methods of the Gaslight and Coke Company, Mr. Goodenough is delightfully interesting; but some of the methods suggested by the experience of that Company would not apply to the rank-and-file of gas undertakings. The size of the Company permits them to departmentalize; and such a gigantic business could not be otherwise conducted. But the gas undertakings that can do this to the same degree are of the minority; and so, in considering some of his points, the exceptional circumstances he has to deal with must be borne in mind.

From the treatment of elementary commercial principles, the author passed to the sales of gas department. He holds that the best results in the direction of increasing the sale of gas cannot be obtained if that side of the business is sequestrated from the routine work of the outdoor staff, and entrusted to a special canvassing staff. The inspectors who are brought most frequently into contact with the consumers must assuredly be the ones who would have the greatest influence and the greatest opportunities; and the system of combining inspection and canvassing has its economies as well as its commercial benefits, especially if men are qualified to impart advice. In the case of the Gaslight and Coke Company, the supply area is divided into 75 districts, with an inspector over each, who is made responsible for pushing the sale of gas therein, and is rewarded according to the results achieved, considered in relation to the possibilities of the district. In addition, however, it is essential to have one or two special representatives to deal with large firms; and the chief inspector has to be prepared to tackle big people and lighting authorities himself, and keep an eye on the manœuvres of electric lighting departments, of which there are in Mr. Goodenough's district no less than ten. Nothing more than this is required to show that he has to be ever on the alert. The author is sound in his presentment of the conditions essential to the success of a forward policy. An undertaking must be not only a gas-supply business, but a gas-service business. The supplying and fixing of lamps, fittings, cookers, fires, engines, and every other kind of apparatus for the use of gas must be undertaken; and (in addition to hiring out) the sale of fittings, stoves, and apparatus of all kinds on the extended payment system is found of great value in developing the sale of gas. The fixing of gas-fires is described as the *crux* of the gas-fire business; and there is much in this. The necessity of well-equipped show-rooms is emphasized; and co-operation with local ironmongers is very beneficial, but not a bodily surrender to them of the business of supplying gas appliances. The maintenance of mantles is another line of activity. Here we learn that the Gaslight and Coke Company find, as on the Continent, material advantages accrue from the substitution of non-collodionized for the ordinary type of mantles; and they are now burning off and using about 250,000 uncollodionized mantles a year. The Company have also proved the advantage of engaging lady instructors, skilled in the use of cooking-stoves, to visit the houses of consumers; and they have now six constantly employed on this work—notification being made to consumers when visits will be made, unless intimation is received that some other day would be more convenient. The Company have likewise been for some months examining and adjusting gas heating and cooking stoves in portions of their district; and such periodical attention is found so desirable that it is being extended. In all directions, too, the staff and the workmen are receiving technical instruction; the Company believing in the benefits accruing to their business through the increased knowledge of their employees. Mr. Goodenough has a strong belief in advertising and circularizing; and he suggests that the question of a joint fund for advertising in publications of general circulation is one to which consideration might well be devoted by the Institution. Touching on the subject of canvassing, there is profit to be gained in sorting out all consumers who use considerably less gas than their neighbours, and giving them diplomatic attention; as well as in making calls on those householders who do not use gas at all. There are many other good points in the paper.

### Commercial Value of Attending to Consumers.

Mr. Tooms represented among the authors the gas engineers and managers of Ireland; and he had some sound advice to tender regarding consumption development by small undertakings. He advances the proposition that the increased use and consumption of gas depend in a far greater degree on the outdoor service rendered to customers by the gas administration than it does on the price per 1000 cubic feet at which the gas is sold; and before he finished his paper, he proved his case so far as the small and moderate sized towns in the South of Ireland are concerned which he took for illustration. But it would be a pity if the holding of that belief resulted in retarding reductions whenever the accretion of business and favourable markets allowed. However, the methods adopted in the towns referred to are of the most broad-minded character. Facilities of all kinds are given for acquiring or hiring gas-using appliances, and for having them fitted. Under this encouraging policy, there have been increases in the consumption of gas during the last ten years in the towns serving for illustration, of from 55 per cent. to 250 per cent., though in every case the charge for gas is relatively high. In the year ending June last, the prices ranged between 3s. 9d. and 5s. 10d. per 1000 cubic feet. The districts for the most part are not those in which bumping increases in consumption would be ordinarily looked for; but the undertakings in the period have certainly done well under the course of enlightened management to which they have been subject.

Mr. Tooms lays down certain rules for the guidance of those in charge of small gas-works. He puts it as being essential for the progress of such works that all the gas-fitting required should be carried out by the undertakings direct. The new movement by which friendly and business relations are established between ironmongers and gas suppliers does not commend itself to him. But we hardly think he fully appreciates the position. Making friends with the ironmongers is only another step forward in the methods which he himself so strongly advocates. There is no delegation of responsibility—the ironmongers merely assist in the advertising and sale of appliances in conjunction with the gas undertakings; and the gas management does not give up any single method which aids in keeping the members of the staff in touch with the consumers. In carrying on fitting work, Mr. Tooms looks for his profit indirectly from the consumption of gas. He says wisely that the gas business in any town, whether there is electricity in competition or not, should be conducted as though the most "deadly competitor" is facing. Advertise, have show-rooms in some main street, circulate literature, keep good incandescent lighting well in evidence in the public lamps, are found in his sheaf of practices. Mr. Tooms does not believe in getting a consumer under false pretences; he would rather make some sacrifice. In Waterford, the price of gas is now 3s. 4d. per 1000 cubic feet; and he, in consequence, some time ago advised, in reply to an inquiry with reference to a 50-horse power engine, the installation of a suction gas plant as being the cheaper system under the circumstances. The most profitable development of business for any undertaking to cultivate he is inclined to think is additional consumption by present consumers. One further interesting point is that he shows that more than 90 per cent. of the gas used for lighting in Waterford is by means of incandescent burners—the flat-flame burners that are still in position being for the most part in places where light is seldom required. It is an interesting little paper. Though it does not deal with business on the large scale, business methods are of equal importance to the small as to the extensive undertaking.

### The Discussion.

The two papers offered a large field over which to ramble; and had it not been for the proximity of the luncheon hour, the debate would have shown remarkable elasticity. It is generally supposed that the ultimate object of debate on these occasions is to extend knowledge; but some speakers seem to think that the intention of discussions is to provide an opportunity for a display of verboseness, rapidity of speech, and unintelligibleness. There might, we venture to suggest, be some consideration for the reporters, who convey the discussion to a larger audience than that present, and also for those who honour the speakers as listeners. The President was correct in describing the two papers as splendid contributions, and so thought the members. Those who took part in the discussion were Mr. Francis T. Cotton (it was appropriate this gentleman should lead off, seeing how greatly the success of the meeting has depended on him), Mr. R. Bruce Anderson, Mr. J. W. Helps, Mr. R. M. Searle, Mr. George Helps, Mr. James Lyne, and Mr. Alex. Wilson, and many more would have spoken, but the length of the

programme made it necessary that the discussion should be completed at this sitting. It was pointed out how similar were the views of the authors (though coming from two such widely situated and differently circumstanced places as London and Waterford) as to the proper way of cultivating the gas business. The Gaslight and Coke Company and Mr. Goodenough were congratulated; and everybody recognized how, during the last few years, there has been such an awakening in the methods of doing business north of the Thames, that the Gaslight and Coke Company are now taken as a pattern of how these things should be done in an up-to-date way. But while the Company have no objection to anyone learning of them, or copying their methods, they would find it somewhat embarrassing to be converted into a sort of central bureau of information on all sorts of subjects, or as the proper people to undertake to receive and administer funds for central advertising work. Mr. Goodenough's suggestion as to a scheme of general advertising, to the expense of which gas companies could contribute, was thought highly of; but Mr. Goodenough did not suggest that his already heavy responsibilities should be enlarged by tacking on to them the general co-operative advertising work of the whole gas industry. There are limits to physical endurance; and Mr. Goodenough has all-sufficient on his shoulders now. Of course, in advertising work there is the difficulty of persuading Directors and Committees that it pays, as the return is not of that direct and obvious nature that carries conviction. But those who touched on this matter in the discussion are well aware that advertising does pay, though the return may be indirect. It is a case of casting bread upon the waters, and it shall return to you after—it may be only a few, but it may be many days.

A large part of the discussion turned on the question of the relations between ironmongers and gas suppliers, owing to the antagonism of the views expressed in the two papers. One or two speakers seemed to think very lightly of the co-operation of the ironmongers; but we prefer to cultivate active rather than apathetic friendship. The greater number, however, thought that some sort of an agreement was a good thing, though an agreement must not go to the extent of converting ironmongers into actual agents. The putting of ironmongers into the position of agents has been found at Croydon not to be the right thing; and the use of the term "agent" is prohibited by the Gaslight and Coke Company. Nor must ironmongers open their mouths too wide, as they appear to be doing at Glasgow, where they want the Gas Committee to hand over to the ironmonger situated nearest the source of the order execution of all orders received for gas appliances. It would be a nice sort of thing for the energy of a Gas Department to be expended in working up business for one section of the city's trading community. The only and proper thing is to make it worth the while of ironmongers to utilize their opportunities in getting business. But Mr. Tooms was not to be turned from his views. Then those who are thinking of trying the effect of lady visitors, teachers, and advisers will do well to note that experience says their visits must be by appointment only. There were speakers who questioned the propriety of inspectors doing canvassing work; as the canvassing and prospective commission might be conducive to neglect of other duties. But the factors of personal acquaintance and opportunity come in here; and the inspector has no equal in these respects. The old cry was raised again that people cannot afford to use gas-fires except in bedrooms. But people do use them; they even use electric radiators. Differential prices for gas-fire business were advocated; but the justification for them was combated in view of the fact that this is a consumption that comes on top of the peak-load, and is what the electricians call a poor load. Mr. R. M. Searle, of Rochester, N.Y., took part in the discussion; and some of the methods he adopts in his business are, to say the least, striking and novel. They are worth reading about.

### At the Exhibition—A Broken Appointment.

In the afternoon arrangements had been made for a visit to the exhibition under the guidance of Mr. James Shanks, Chief Executive Officer, and members of the Executive Committee. The time appointed was four o'clock. At that hour, the members of the Executive Committee were waiting to receive their visitors; but no visitors put in an appearance until certainly half-an-hour later. This was not very courteous; but explanation and apology were made by the President at the luncheon given the following day by the Chairman (Alderman W. F. Cotton, D.L., J.P.) and Directors of the Alliance and Dublin Consumers' Gas Company. A member of the Executive Committee absolved the members from intentional discourtesy. In the evening (Tuesday) there was an inspection of the Gas Pavilion and outdoor lighting under the guidance of the Chairman of the Works' Committee, Alderman Cotton. Some impressions on this occasion are recorded in an independent article (p. 922).

### A Deficit in Benevolence.

Ten o'clock is not an early hour for business men; but at the meeting of the subscribers to the Benevolent Fund at that hour on Wednesday morning, there was a very poor attendance. The indifference of such a large proportion of the members to the fund is regrettable. This is apparent not only in the attendance at this one meeting during the year, but in the fund itself. A donation of £50 was made to the fund by the Organizing Managers of the Engineering and Machinery Exhibition; and had it not been for this and other donations, there would have been a deficit of upwards of £50 at the close of the year. The appeal through the District Associations has not met with much response; but something will have to be done, if the good work is to be continued on the present scale, to increase the subscription list. The President regretted the apathy, and Mr. Hepworth that such an appeal should fall on deaf ears. It was suggested by Mr. Irving that the matter should be again introduced during the ordinary sittings when there was a full attendance; but this was not done.

### Friends from Across the Seas.

At this meeting the Institution were honoured by several visitors from abroad, all of whom were most cordially welcomed by the President, and invited to sit with him on the platform. His attentions to the visitors were heartily endorsed by the members. But among the visitors, there was not one who received a greater ovation than Mr. Mizuta, one of the Engineers of the Tokio Gas Company, who put in appearance on the Wednesday morning, and continued in attendance until the close of the meeting.

### Distribution at High Pressures.

The chronicles, the library, and the "museum" (if one exists) of the Institution have been enriched by Mr. R. M. Searle, of Rochester, N.Y. He read a paper on "High Pressure Distribution Development in the United States." He brought a collection of published matter and MS. giving a history of all things relating to the subject so far known in America; and he also gave to the Institution specimens of various connections and appliances used in high-pressure pipe work. There was no doubt about the pains he had bestowed on his contribution, so as to make it as complete as possible; and the President and members were unstinted in their praise and acknowledgment of their indebtedness. In the United States, high-pressure distribution is generally understood to be 5 lbs. per square inch or over; and 50 lbs. per square inch in mains just before peak-load comes on is not uncommon. As in this country so in America, when there is innovation in practice, gas engineers have had to feel their way in adopting that which is most suitable.

From Mr. Searle's paper many points affording guidance will be obtained. The best pipes to use under "all" circumstances are wrought-iron pipes; and in laying them malleable recessed screwed couplings should be used. Developments have shown that gate-valves should be put in mains every half mile; and that expansion joints (preferably of the Dresser type) should be fixed every 1000 feet. In some of the original installations, contraction and expansion were not provided for; and this resulted in serious loss, damage, and inconvenience. Connections between mains and lateral mains are described; and notes on drips and pipe coating are found. There is one thing that engineers who have undertaken the distribution of gas under the high-pressure system have been somewhat dumbfounded over, and that is to find how much gas can be pushed through a small pipe. There is money to be saved in paying attention to this question; and the author advises the use of Cox's gas-flow computer (a sample of which he left with the Institution), which is accurate enough for all economical purposes. An important section of the paper is a letter on the general question by Mr. H. L. Rice, the General Manager of the Western United Gas and Electric Company. It is full of hints. One point is striking: In general, writes Mr. Rice, an ordinary good quality coal gas can be compressed to 40 lbs., and delivered 50 miles to consumers, and give satisfaction. He is speaking here of the

ordinary community using gas ranges, and doing its lighting largely with incandescent mantles, but with occasional open flames. The open flames will not be so good as with gas before compression, but they will pass. Later in the paper services and methods of connection are discussed with more detail; and in this connection a simple tapping-machine was shown, a sample of which was also presented to the Institution. Safety seals, governors, and compressors are likewise discussed; as well as pulsation and storage tanks. The loss in candle power due to compression and transmission is one which no engineer can afford to overlook. The author, like many other engineers, is satisfied this is a factor which must be reckoned with. Some very reliable data showing a drop of 11 per cent. at 5 lbs. pressure have been obtained in respect of gas transmitted for 8 miles, which is about double the loss of candle power of the same gas when sent out 8 miles on the low-pressure system. One of the incidental complimentary apothegms used by the author was "You can always tell an Englishman; but you can't tell him much."

Such an important contribution could not fail to produce not a critical discussion, but supplementary and interrogatory. A round dozen speakers or questioners popped up one after the other before the President had to call upon Mr. Searle for his reply. In the order in which they spoke, the contributors were Mr. George Helps, Mr. W. R. Herring, Mr. Edward Allen, Mr. F. W. Cross, Mr. S. Meunier, Mr. T. Canning, Mr. A. W. Onslow, Mr. Alex. Wilson, Mr. S. Y. Shoubridge, Mr. Douglas Helps, Mr. Thomas Glover, and Mr. T. J. Reid. Among the points that outstood all the others was the value of the high-pressure system of distribution in feeding districts where there is a shortage of supply. When high-pressure distribution is referred to in this country, the stock examples of Beckton, East Greenwich, and Nuneaton are mentioned; but when the matter is inquired into, it is found that there are a good many more examples than one has been led to expect. There has been much hiding of one's light under a bushel in this connection. We have learnt recently, through Mr. Herring's new book, a great deal more about the high-pressure system he has in use in Edinburgh; and, in addition to that example, reference was made at this meeting to Newport and Stockport, and the older example of Nuneaton. Many more illustrations are to be found throughout the country—of course, not extensive, but still representative of the system. At the same time, the slow extension of this useful system requires some explanation; and the one that Mr. Herring gives is that we are in this country tied up to the testing of flame luminosity. The author suggests in his paper, as we have shown, a loss of 11 per cent. of illuminating power at 5 lbs. pressure; and this is a rather serious matter where the photometer is the arbiter of good service. But others, while acknowledging a loss of illuminating power, do not regard it as anything more than insignificant. There were in the discussion many remarks about uniform pressure. There is a division of opinion whether high pressures assist in producing uniformity, or really create inconvenience to the consumers. If they do, it is suggested that they can be dealt with by governors. It is remembered what Mr. Rice said on this point in his communication to the author; and, in another part of his paper, the author gives a table compiled by Mr. C. W. Bradley, of the North-Western Gas and Coke Company, in which he shows that in the three months ending March 19 last, there were on the high-pressure line from Edison Park to Barrington only 49 complaints; and all of these had reference to small repairable defects, connected with valves, regulators, &c. Higher pressures also assist in saving capital in the enlarging of mains; but there is a matter here on which emphasis is laid by one or two critics —that very small pipes have a tendency to create friction, and friction has an effect on illuminating power. High-pressure distribution for certain purposes is nevertheless of proved excellence. Mr. Onslow's interesting contribution to the discussion had reference more to a use of high-pressure gas than to its distribution. For heating in metallurgical work at Woolwich Arsenal, it is found that pressures of 60 inches cause the temperature to rise very rapidly. There is great economy of time due entirely to heating by this means instead of by anthracite coal or foundry coke.

### Testing and Hygienic Efficiency of Gas-Fires.

It was good to listen to the paper by Mr. J. H. Brearley on the rather neglected subject of the testing and hygienic efficiency of gas-fires; and the author well deserved all the encomiums bestowed upon him for the unique lines of his research. Mr. Brearley is on the Committee appointed by the Council of the Institution to investigate the subject of the economical use of gas for heating; and he and his present paper will undoubtedly give the inquiry a start on correct lines. The work that he has done so far is valuable, though in some parts inconclusive, owing to time, opportunity, and not in every direction of test completely developed and trustworthy means. Mr. Brearley has had to largely explore, to determine the methods of testing, before being even partially satisfied with the results; but the credit is his that he has done a considerable amount of spade work in this matter that supplies good ground from which to prosecute the inquiry now in hand. The paper shows that the efficiency of a gas-fire cannot be adjudged from any single point of observation, and that it is altogether a complex subject. However, the author has up to a point conquered difficulties, and qualified himself for many useful suggestions; and through this there is the greater hope that the concentration of the talent which the Council are, through their Sub-Committee and the Leeds University, bringing to bear on gas heating will produce good fruit.

It is true the subject is one which craves for all the research and attention that can be brought upon it; for gas heating offers a field that has been but apathetically regarded, though in the present the gas consumption for this purpose is a fairly substantial one. But it is not what it should be, if gas-fires were only intelligently applied. Gas-fires, our present mentor declares, should be as systematically tested before buying quantities as gas-burners; and his test-figures confirm his view. But there is the rub. The testings must be scientifically conducted; and they are not so easily performed as testings for illumination from a single source—such as a gas-burner. Look at the paper for corroboration. Mr. Brearley's tests cover radiation, flue heat, heat of convection, carbon monoxide, flueless stoves, and several other points—each and every one of which required some different treatment in testing. The methods adopted refuse to submit to epitomizing; and therefore we will only point out a few of the conclusions to which research led the author.

The figures show in a forcible way the importance of the problem of radiation; and there is exemplification of the value of the media for utilizing the heat in the form of radiant energy. It has always been understood that iron frets give off a greater proportion of radiation than fire-clay fuel, though in Mr. Brearley's tests the latter only comes out about 8 per cent. below the former. The public prefer the fire-clay balls to iron frets; and there has to be submission to public taste. But in the fire-clay balls has finality been reached? Are we assured that the variety as to composition, shape, colour, &c., in common use develops the highest amount of radiation? The answer can only be in the negative; and therefore we must await the verdict of thorough research. The tests also indicate that no fire-clay fire without suitable gas and air adjustment should be fixed with a less pressure than 1½ inches; and that, even with adjustment, the efficiency is much lower at 1 inch than at 1½ inches. The value of the duplex-tap arrangement for extinguishing end burners when a fire of lessened power is required is demonstrated as being preferable to turning down all the burners. A slight curvature in the bunsen burner has also the effect of more evenly distributing radiation than a straight burner. A very high air temperature is given by a fire with air-tubes filled at the back, but (the tests, reveal) at the expense of radiant duty. A thin body of fuel is also essential to radiation efficiency. Gas and air adjusters receive high testimony for their value. The author has been beset with much difficulty in testing for heat carried away in the waste products; but any way he succeeded in obtaining an improved method of measurement. Whether the method can be regarded as even approximately exact cannot be said; but there will be a little scepticism when the wide variations of the figures are examined. We must here pass over much else in the paper; but it may be noted that later on, Mr. Brearley, taking into consideration all the facts he advances, submits that gas-fires do not produce carbon monoxide when properly constructed and kept clean. Again he is obviously no lover of flueless gas-stoves; but he does not go so far as to endorse Professor Lewes's dictum of 1902, that "a gas company which sells a flueless stove, except for passage and hall heating, should be prosecuted." What he does contend is that, unless ventilation is adequate,

flueless stoves should not be fixed in living or work rooms. Two makes of steam-radiators tested he reported passed practically the whole of the carbonic acid into the room. He gives no ground for doubt as to his view that flueless stoves, after all, are not so economical of heat as is often concluded; nor can he conceive how such stoves can effect much economy as compared with a properly designed gas-fire if the same standard of purity in the atmosphere is maintained. On the question of humidity, so far as the author has carried his investigations, they indicate that, if the temperature of a gas-heated room is properly looked after, complaints of dryness are unlikely.

**Professor Lewes and the Flueless Stove.**

If there was one point in the discussion upon which all were agreed, it was that, while there is room for scientific improvement in gas-fires, they are not nearly so bad as they are painted, when intelligently fixed and used. The comfort and the saving of labour realized by them are indisputably immense. The debate was a long one, and not altogether devoid of incident—good humoured, but expressive. Those who took part in it were Mr. R. G. Shadbolt, Professor Vivian B. Lewes, Mr. H. J. Yates, Mr. Walter Grafton, Mr. H. M. Thornton, Mr. Thomas Glover, and Mr. F. W. Goodenough. Many of the remarks made, however, were not pertinent to the special subject of the paper; and much that was said was purely hypothetical. Discrepancies were pointed out in certain of Mr. Brearley's figures, which he explained. But the discussion warns against the publication of figures regarding products of combustion and their passage into rooms that are not substantiated by results from tests more critical and exacting than certain of those in the paper. It was Mr. Shadbolt who, examining the author's figures, found that he declares the products bye-passing up the front of a stove range between 22·3 per cent. and 50·8 per cent. These astonishing figures Mr. Shadbolt described as remarkable. It was Mr. Walter Grafton who was sorry the carbon monoxide tests had been given. His experience is that gas-fires do not give off into a room carbon monoxide; and this is the result of repeated experiment. In actual practice, too, Mr. Goodenough has never met with such a percentage of products as 50 in a room.

In repeating his old attack on flueless gas-stoves, Professor Lewes brought a hornet's nest about his ears. He declares that flueless gas-stoves have been the gas industry's worst enemy, and that they started the war cry against gas-fires. Professor Lewes was a bit out of his reckoning in this matter. The source of such offence as gas-fires have given has been the fitting of fires by incompetent men. This is proved by the fact that the use of gas-fires is now extending; and the rate of return of fires is fast diminishing. Gas managers doing business with consumers are the better judges of this. Professor Lewes also asserts that one might as well have an open bunsen in a room as an elaborate stove. There, again, the bunsen cannot be such a centre of heat for the purpose of warming a room as a cased-in gas-fire, the casing of which becomes hot, and so presents an extensive heating surface. Professor Lewes again is contradictory in the expressions he uses. Having stated that flueless stoves started the war cry against gas-stoves, he later on says that the "popularity" of flueless stoves is due to the small amount of gas they consume, compared with the fuel variety of fire. How can they be at once popular and objects of execration? Mr. T. Glover pronounced the Professor's statements on flueless stoves as far too sweeping; and he emphatically declared that gas engineers are as high principled in this matter as Professor Lewes. He referred to the fact that flueless gas-stoves are used for the heating of Maple's large show-rooms. Mr. Goodenough improved the occasion by asserting that there were times when theory was better than practice; and Maple's is an instance. There electric radiators are sold; but flueless gas-stoves have been fitted in the show-rooms for economy, and because there are no chimneys there to which the ordinary gas-fire can be connected. However, Professor Lewes was made fully aware, by the dissent that greeted his statements on this subject from all parts of the hall, that his views in their comprehensiveness are not those of practical gas engineers.

Leaving this subject, there were numerous points made affecting Mr. Brearley's tests, also asserting the improvement that the makers have already made in gas-fires, and acknowledging the possibility of further advance in efficiency. A point for the consideration of the Council is the one made by Mr. Thornton that the gas-stove makers would be pleased to co-operate, if permitted, in the investigation that is about to be instituted.

**A Luncheon.**

After the morning sitting, the members proceeded by tramcars to the Herbert Hall of the Irish International Exhibition, where they were entertained at luncheon by the Chairman and Directors of the Alliance and Dublin Gas Company. A special report appears on p. 906.

**The Use of Gas from a Hygienic Standpoint—A Hint to Gas-Fire Makers.**

The Lecture Theatre on Wednesday evening was well filled with a company such as delights Professor Vivian B. Lewes. Members were present in good numbers; and their more sombre evening garments were relieved by the dainty costumes of the many ladies present. Several visitors resident in Dublin were also there. The popular lecturer was at his best; and his apparently inexhaustible fund of humour introduced just those light streaks that cause a technical subject to appeal to, and to be understood by, a mixed audience—some of whom know as much as the learned Professor can tell them of these things, while others cannot appreciate them unless the matter is put into the simplest of language. The subject was "The Use of Gas from a Hygienic Standpoint." The Professor demonstrated how it is that the human being has a greater contaminating influence on the air of rooms than gas-burners; how it is that the use of gas-burners has an immense purifying and ventilating effect; and how it is that the air of an occupied room lighted by electric means becomes greatly polluted by human exhalations. We would urge technical readers not to think that because the lecture was of the one part popular in style, that there is therefore nothing to be learnt from it. The other part contains much useful and valuable information both to the technician and to those who are concerned in the commercial development of the use of gas. To instance one point. The lecturer dwelt upon the high radiative value of ceria. Pure ceria will translate 48·2 per cent. of the calorific value of the gas into heat radiations. Experiments were made with a fire-ball taken from an ordinary gas-fire. It was dipped in a dilute solution of cerium nitrate, reignited, and, on testing, was found to give an increase in radiation of 12 per cent. The experiment shows that it may be possible, at any rate to this extent, to increase the radiative power of the material heated in a gas-stove. It was mentioned that Mr. Edgar is making a radiative fuel on this principle. Even Sir Charles Cameron, the City Analyst of Dublin, was interested in the lecture, and confessed that it had proved very instructive to him. There are tables in the lecture which ought to be carefully looked into by gas officials of all positions. The lecture was illustrated on almost every point by successfully conducted experiments.

**Thursday's Business.**

The final sitting on Thursday morning was a very full one; and the members were summoned to meet as early as nine o'clock, and did not conclude their deliberations until nearly five hours later. But, by the judicious conduct of the proceedings by the President, the heavy programme was dealt with with little indication of rush.

**Progress in Incandescent Lighting.**

It was rather a big task that Mr. Harold E. Copp undertook when he consented to read a paper on incandescent gas lighting, with special reference to the inverted type of burners. The points that one can now talk about in connection with incandescent gas lighting are legion; and Mr. Copp's paper can be taken as merely limning some of the many matters that cluster round these points. When the author sat down to his task of preparing the paper, he became more and more aware that the point of compression to which he would have to go would mean great sacrifice; and the sacrifice he made is patent throughout the paper. However, he did the best under the circumstances; and the sketch reads well, and also made good hearing.

We must all agree that, with the multiplication of burners that are now offering to the public, it is necessary that those who are responsible for advising consumers should be in a position to recommend the best mantles and burners for the particular purpose required. Indication is given in the paper that there are many directions in which further improvement can be achieved in incandescent lighting; but this must be borne in mind—and it is borne in mind without

the slightest regret, as the recuperative power of the gas industry has shown a very amiable disposition in the past and promise for the future—that further improvement means further reduction in the consumption of gas for the illuminating service rendered. Mr. Copp deals largely with inverted gas-burners; and he makes several suggestions, which are approved by those of experience. He points out that few inverted burners will work satisfactorily with less than 1½ inches pressure; and he advises that it is essential for distribution pressures to be more constantly maintained than formerly. Present-day conditions, too, require that where an admixture of water gas and coal gas is distributed, the proportions should be as constant as possible—inverted gas-burners being particularly susceptible to variations in the composition of the gas. The ideal burner is described as one in which sufficient air is injected and mixed with the gas for its complete combustion, as from the resulting flame the maximum temperature would be developed. But in practice, at any rate with vertical burners, it is only by forcing the mixture through a small orifice at high velocity that these conditions can be approached. Mention is made of the fact that the form of the injector of a burner bears a very distinct relationship to efficiency. It is seen that Mr. Copp is not favourably disposed to the use of mechanical adjusters, the best form of which he finds to be one in which the hole is maintained fairly circular in form, or in which, if there are more than three holes, the adjustment is made by closing them successively. A needle-valve he declares gives a lower efficiency. Mr. Copp prefers, when fitting up an installation, especially of inverted burners, to take a record of the pressure at the point where the burners are to be fixed, and to adjust them to the exact conditions (in the test-room) before they are sent out. That is all very well if there is any certitude as to the pressures at these points being undisturbed by works or local influences. It is because of the uncertainty that we have found mechanical adjusters to be very useful for regulation at any time and in any place. The author also emphasizes the importance of the shape and design of the mixing-tube. He does not trouble much about the theory of mantle luminosity; but, to attain maximum illuminating power, he gives heed to the practical object of getting a flame as hot as possible by effective injection and perfect mixture, and to shape a mantle of the right texture and composition to that flame.

Time and experience have caused many changes of view in connection with the structural details of inverted burners; and have shown where in such detail the pioneers were wrong and where they were right. We will not go with the author into any of these matters, as the most interesting point that is to be found in this connection is the burner the author has designed, and which he therefore doubtless conceives to be the *ne plus ultra* in this connection. In it the tube is enclosed in a chamber through which the primary air reaches the injector, so that, as it becomes hot, and the tendency of the mixture to descend is lessened, that of the primary air is correspondingly increased. In practice, the flame of this burner remains nearly as atmospheric when hot as when first lighted, and the inner cone does not perceptibly lengthen—"the heating of the mixture giving it a high efficiency." Other advantages of the burner are referred to in the paper. The author also speaks highly of Mr. George Helps's ingenious device, whereby the injector can be easily removed for cleaning purposes. Others have also found this to be of considerable advantage in maintaining efficiency. Many other "wrinkles" guiding to the choice of good inverted burners are scattered through the paper.

The author does not consider that the self-intensifying incandescent system has made any marked progress recently; and with regard to pressure systems of lighting, he inclines to the view that the top-high pressures employed give more satisfactory results than the lower high pressures. He has a good word to say, too, for the air-pressure systems. There has not as yet been any great enthusiasm over the adaptation of inverted burners to high pressure; but Mr. Copp says his experience is that several types of inverted burner can be utilized for high pressure gas by fitting them with a smaller injector, and attaching a nozzle to impart the correct shape to the flame. Regarding mantles, it is his hope that the new ones will prove as satisfactory as they at present promise to be. He also, like the Gaslight and Coke Company (mentioned in Mr. Goodenough's contribution), finds it profitable to obtain uncollodionized mantles for maintenance and street lighting, and to burn them off as required. There is corroboration at the end of the paper of a very general experience, that inverted burners are much less costly to maintain than vertical burners. The automatic ignition of incandescent burners also claims consideration.

Before the discussion commenced, the President announced that he had received a telegraphic message from M. Payet, the Permanent Secretary of the Société du Gaz en France, expressing regret at his inability to be present, and wishing the members a successful meeting. This was applauded; and then the members set themselves to attack with freedom some of the conclusions arrived at by Mr. Copp. It should be remembered that the results were realized under the conditions existing at West Bromwich; and that is where the weakness in the value of such tests as the bases of comparison is found. The numerous points taken up were dealt with critically, particularly by Mr. W. R. Herring, Mr. R. Watson, Mr. G. Helps, and Mr. Walter Grafton. Other speakers were Mr. Arthur Bray and Mr. C. W. Bland. The influence of pressures in incandescent lighting was the most prominent of the general features of the debate. The incandescent burner has undoubtedly created a necessity for higher pressures than we have been accustomed to; and with somewhat higher pressures—not too high with ordinary burners—greater efficiency can be attained. It seems to be generally conceded that the best efficiencies are to be obtained by the delivery of gas at higher pressures than 15-10ths. Take, for high illuminating quality, the Edinburgh 20-candle gas. Mr. Herring says the best efficiency he can get with ordinary burners is with pressures of from 25-10ths to 30-10ths; and with inverted burners, using the 20-candle gas, he obtains about 30 candles and up to 34 candles per cubic foot. Take a lower illuminating quality of gas such as is supplied at Doncaster. Mr. Watson finds there that he obtains the best results at 20-10ths pressure, but that the illuminating power of ordinary burners per cubic foot falls away after passing a pressure of 25-10ths. This shows the important influence of pressures. But, as Mr. Herring points out, it is physically impossible to know what pressure there will be in any particular locality at any particular time, unless every house is governed independently of the street system. He lays it down that the success of the incandescent system must not depend upon the adjusting of a burner for every position it has to occupy; but what is wanted is a burner that will meet the varying conditions as they are found. We are inclined to disagree, from experience with low illuminating qualities of gas, with those who are not in favour of gas adjusters on each burner; but we do agree, also from experience, with those who point to varying compositions of gas giving varying results. The necessity of keeping the air supply to inverted burners unvitiated by the products of combustion is a matter of great importance, which was insisted upon in the course of the discussion.

### International Photometrical Committee—A Protest by Mr. Isaac Carr.

The President interposed here a resolution that affected the Institution's delegates—Mr. Charles Carpenter and Mr. J. W. Helps—to the coming meeting of the International Photometrical Committee. These gentlemen desired (and very naturally) to go to the conference armed with instructions from the Institution; and, as recent legislation has favoured the adoption of the 10-candle pentane lamp and the Metropolitan argand No. 2 burner as standards, the President proposed a resolution expressing (after a little amendmend) the opinion of the meeting that these should be the recognized standards for gas up to and including 20-candle power. Only recently it was suggested in the "JOURNAL" that it would be a good thing if a universal system of gas testing could be established, in the interests of scientific progress; and therefore we consider that the members of the Institution were correct in expressing their opinion in favour of the standards. At the same time, it must also be admitted that Mr. Isaac Carr was, later in the proceedings, equally within his rights in protesting against the passing of resolutions without due notice. The matter, however, was one of urgency, and could not be delayed; and whatever little irregularity there may have been is absolutely excusable under the circumstances.

### Tar for Roadways.

Mr. H. P. Maybury was the author of the next paper; but in his absence it was read by the Hon. Secretary, Mr. J. W. Helps. It was on the use of tar on roadways—a subject that Mr. Maybury has entered into with prominence.

Though now the County Surveyor of Kent, which position does not include, as did his triple office at Malvern, the management of gas-works, Mr. Maybury retains a link with gas through continued membership of the Institution. His old experience and work in the gas industry have no doubt been exceedingly helpful to him in assisting tar into a new field of utility in connection with roadways. We all well know what started this question of improving the surface of the roadways; and Mr. Maybury considerately did not encumber his paper with a lot of particulars with which every newspaper reader is cognizant. It is now generally conceded that there is nothing so effective as tar for improving the roadways; but the rate at which improvement will proceed is controlled by finance. Mr. Maybury looks hopefully to a financial scheme being propounded which will be equitable, and which will put the cost of road improvement and dust abatement more directly on the users of the roads. The cost of upkeep has gone up tremendously; and the ratepayer has had to bear not only the additional burden, but the nuisance occasioned by modern traffic. The duty imposition is unjust. According to the author, there are 23,826 miles of main roads, and 95,211 miles of other public roads, in England and Wales. Taking the main roads only, and leaving out of consideration those classed as public roads, it is calculated that to tar surface them some 33,400,000 gallons a year would be required, and that the value of this quantity would be something like £208,000, at 1½d. per gallon. The 1½d. is rather a high figure to take for present-day tar prices—at any rate in and around London. The view is endorsed that it should be the aim of every gas engineer to encourage in his immediate neighbourhood the use of tar for road purposes by putting the purchasers upon the most favoured nation terms. We have no sympathy with those gas suppliers who, through greed, deliberately ostracize themselves from their own local markets. There are such; and Mr. Maybury has come across them. However, on the general subject, he has had good past experience, and has tried all methods of using tar for roadway purposes. He likes his roads made of the best hard material, bound together with clean gravel and granite chippings; the tar being applied as a surface dressing after the road has well dried out. The paper was not a long one; but it was full of encouragement—not the least notable point in this respect being that Mr. Maybury has instructions to treat with tar some 200 miles of the most important roads from London to the coast.

The discussion on the paper was not long, but several members had a little say on the subject. The chief matter was about an equal division of opinion on the question of the price of tar sold for road purposes. Protest was made against 1d. per gallon being regarded as a standard price; but no one has suggested that 1d. should be the standard price. What has been suggested is that every encouragement should be given to developing this new outlet for tar, and not to smother it at the outset by asking high prices. It has been proved that tar has a value in the making of good roads exceeding the mere suppression of the dust nuisance; and as the good results of this become more and more apparent to road authorities, they will naturally be prepared to pay a higher price for the material that realizes them such considerable economy in road maintenance. If by the absorption of tar for road purposes the supply is decreased, the tar distillers will perforce have to pay something that is more in accordance with the value that the tar is to them. What has to be done now is to encourage that which will give the tar a higher prospective value. The 1d. a gallon is about the price that the London Companies can obtain at the present time; if other places get more, then that is something upon which they may be congratulated. But it must not be forgotten that the sources of production are ever on the increase; and we want the ratio of demand and supply not to proceed *pari passu*, but the demand to increase at a greater pace than the supply. One point in the discussion was the excellent character given to Mr. Reeson's machine for applying tar to road surfaces.

### Gas from Bye-Product Coke-Ovens.

It cannot be said, after listening most attentively to the papers presented on the bye-product coking process, that they greatly advanced the case for recovery coke-oven practice yet becoming part and parcel of a gas-works operations. There is much still to be learnt; but we are not associated with the view of those who already believe that carbonization in larger bulk than at present for gas making cannot prove profitable. In making these remarks, however, it is not intended to convey that the papers were destitute of interest for gas engineers, as it is their concern to be kept fully informed of what is going on next door to their own operations, though the operations have at present different primary purposes.

The first paper was by Mr. Paul Schlicht, of New York, on the financial significance to the gas industry of the modern bye-product oven. The paper contained a great deal of introductory matter, revealing the author's close association with the investigation of the subject, as well as a mass of tabular statement which, without a prolonged and critical examination, does not enable a very fair indication to be given here of the more significant features of the communication. The author is thorough up to a point; but if he had given a succinct statement of his conclusions at the end of the paper, it would have been very helpful. Early in his investigations, he formed the opinion that the principle of carbonization in bulk in long narrow chambered coke-ovens with regenerators, and direct uniform heat application, coupled with a simple but efficient system of bye-product recovery that did not too slavishly follow the methods in vogue in ordinary gas-works practice, and that was designed with special reference to the bye-product oven, was absolutely sound when considered as the alternative of the gas-retort system. Something, however, in proof, is still wanted—more definite than the figures given in the tables of "Comparisons of Bye-Product Oven and Gas Retort Carbonization." Table III. has a heading which commences "Comparative *Possible Approximate* Yields," &c.; Table IV. a heading commencing "*Estimated* Comparative Results per 1000 Cubic Feet," &c.; Table V., a heading "*Estimated* Comparative Results," &c. Those things that are possible, approximate, and estimated, all come out showing a considerable advantage on the side of the bye-product coke oven. Later on, there is an analysis of the "actual labour employed and costs of oven and gas-retort carbonization per 24 hours (three shifts, England), 400 tons of coal per day." Here we have the labour cost per ton of coal carbonized in ovens given as 8·8d., and in retorts as 16·4d., which latter figure, as things go now, is extraordinarily high, excepting perhaps in works where the conditions as well as the small quantity of work to be done are uneconomical. The art of bye-product oven building is treated upon by the author at some length; and later in the paper, he gives Mr. George Wilton credit for improvements. The author's study of the subject convinces him that there is now greater recognition on the part of gas companies of the advantages of carbonization in bulk and the substitution of a high-grade for a low-grade solid fuel. The author is of opinion that with bye-product coke-ovens, coke suitable for all purposes—open fires, locomotives, and metallurgical purposes—can be obtained by simply varying the coking period. Speaking of the demand for sulphate of ammonia, tar distillates, and benzol, he submits that a bye-product oven installation permits the making of very large discounts from estimates. Turning back to the estimates in the earlier tables, it is seen that the bye-product oven is credited with about 5 lbs. more sulphate per ton of coal carbonized than gas retorts; the quantity of tar is the same; benzol 1·4 gallons, against 0·9 gallon; and cyanogen, 1 to 1½ lbs., against 2 to 4 lbs. From the United-Otto ovens, 5000 cubic feet of surplus (19-candle) gas is mentioned; but the author says 6500 feet should be obtained. In his exploiting work in the United States, Mr. Schlicht does not appear to have met with very great success. When he raised the question with important gas companies in several large cities three years ago, the "only" valid objection advanced was the necessity of creating a demand for the improved coke. "When such objections were made, the author invariably made proposals to erect a bye-product plant to furnish gas at 33⅓ per cent. less than they were producing it for, providing they made a contract for a period sufficiently long to warrant his financing the proposition." Perhaps the working of those companies was not so economically conducted as it might have been. But whether that is so or not, with them the matter introduced by Mr. Schlicht remains in abeyance. But, after all, it is not clear that the author is altogether convinced that the satisfactory solution of the question of carbonization in bulk for gas purposes is an accomplished fact, inasmuch as he states towards the close of his paper that his belief is that the satisfactory solution is "near at hand." The figures given in the appendix to the paper are interesting; and we imagine that they are to be taken as the tests in the United-

Otto ovens with "Black Band" coal. But the figures are not altogether admissible for comparative purposes with British gas-works operation, in view of the differences in the character of the coal that was dealt with.

The paper which Mr. C. E. Rhodes, of Rotherham, presented, and which was read in the author's absence by Mr. J. W. Helps, we are afraid did not advance matters much, though it helped to vary the information. The author is of opinion that the vertical-flued oven with a regenerator provides more surplus gas for lighting and power purposes than any other type of oven. How much more does not seem to have been determined—seeing that later in the paper this statement is made: "It is claimed that the vertical-flued ovens have no less than half the total gas produced to spare; but this has not yet been proved, because there are no means of measuring accurately." Mr. Rhodes directed attention first of all to the working of an installation of horizontal-flued ovens. The coal used in these ovens show, on analyses, a gas yield capacity of between 10,000 and 11,000 cubic feet; but in a week's trial with the horizontal-flued ovens, a make of 9000 feet was shown. And a further trial, after the requirements of the ovens had been satisfied, only exhibited an excess of 1750 cubic feet of gas of 400 to 450 B.Th.U., and from 8 to 9 candle power. The author indicates that this gas has been used during the past two years for the lighting of a colliery village, which had had a small ordinary coal-gas plant in use for some years. An average per day of 27,000 cubic feet of the coke-oven gas has been benzolized from 8 to 9 candle power to 14 or 15 candle power; and a saving to the colliery of some 800 tons of small coal per annum has been effected. The question of utilizing the surplus gas for motive power has also been considered, but at present rejected owing to the varying gas-producing capacity of the ovens with the coal used, the varying quality of the gas, and the necessity of erecting large holders to counteract the variations in supply. Regarding the gas from the installation of vertical-flued ovens, the author does not give much information, as he has not yet obtained accurate data by measurement. But the calorific value he puts at 450 B.Th.U. during the early part of the coking process, and 350 B.Th.U. at the later part. The gas from this plant is being used with satisfaction in two Körting engines for generating electricity. A little trouble arises from the tar in the gas, which it is almost impossible to eliminate; and this necessitates somewhat frequent cleaning of the valves. The liability of the gas, however, to pre-ignition necessitates the reduction of the compression from what was originally designed to about 80 lbs. per square inch. The analyses of the gas from the horizontal and the vertical-flued ovens are given; and they show fairly considerable variations one from the other. Nor are the results of the analyses exactly of the kind that would please the heart of a maker of gas for ordinary distribution purposes.

In the paper presented by Mr. Ernest Bury, he practically confessed at the outset that much of what he had to say was purely hypothetical—that he, in fact, had not sufficient material for any perfect comparison or actual commercial results. It is instructive to know how largely the bye-product coking industry has developed—a development that is likely to continue—because that industry has to be accepted as a contributor, and a contributor growing in prolificness, to the supply in the gas industry's residuals markets. It may be worth inquiring in some places whether a portion of the coke-oven gas generated could not be utilized by the gas industry. Dr. Schniewind in his Glasgow Engineering Congress paper stated that, at Everett, of 10,390 cubic feet of gas per ton produced, 5143 cubic feet of 14·7-candle gas are available for lighting after enrichment; and other authorities quote 3500, 3400, and 3100 cubic feet per ton. Mr. Bury's views are in the region of 3000 cubic feet. He thinks it is quite feasible to apply the rich gas evolved in the earlier stages of the coke-oven process to the lighting of townships in the neighbourhood of coke-ovens, but does not go farther than that. Mr. Bury institutes comparisons to ascertain the possibilities of employing the whole of the gas generated from the bye-product process for towns' lighting. In the course of these comparisons, it is learned that the rate of carbonization per 1000 square feet per hour for the gas-retort is 2·13 tons, and for the coke-oven 0·55 ton; and from the inquiry we emerge fully convinced that, considered merely as a gas-making apparatus, the retort is superior to the coke-oven. A diagram shows certain tests which give a yield of 10,137 cubic feet of gas of 14·25-candle power and upwards of 600 B.Th.U. (which is not regarded nowadays as superlative working) from ordinary gas-retorts; and a yield of 9000 cubic feet of 11-candle gas of an average of 546 B.Th.U. from the coke-ovens. The time may come, but it is not yet, when such a gas would be acceptable. Mr. Bury presents other matters that are against the coke-oven as gas-making apparatus. The labour economies of carbonization in bulk are pointed out. But then we alight on an estimate for a plant of fifty ovens, capable of dealing with 480 tons of slack per day. Given a yield of 9000 cubic feet of gas per ton of a calorific value of 540 B.Th.U., the total yield of gas from this plant would be 4,320,000 cubic feet. But there is cause for pause when it is found that the first cost of such a plant is from £80,000 to £90,000, and that the author estimates that, to complete the installation as a gas plant, there would require to be added for holders, purifiers, meters, governors, and mains a further sum of £92,000, or a total of £182,000. Solely from the gas maker's point of view, the outlay per million would be rather staggering. Of course, it must be conceded that labour charges are low. Towards the end of the paper, we get worked out the cost of making 9000 cubic feet of coke-oven gas of 540 B.Th.U. per ton. as 13·38d. per 1000 cubic feet. The value of the residuals per 1000 cubic feet is put at 1s. 0·3d.; and adding depreciation, rates and taxes, the cost of the oven gas up to leaving the works is stated at from 4d. to 5d. per 1000 cubic feet. But this says nothing about the interest on the expensive plant. The figures do not look tempting when all things are considered.

The discussion did not contribute much to general enlightenment; the fact of the matter being that the material at command is too inconclusive for valuable criticism. The speakers were Mr. T. Glover, Mr. J. P. Leather, Mr. R. M. Searle, Mr. Edward Allen, and Dr. Colman. Mr. Glover brought to mind the President's contribution of some years ago to this subject; and he pointed to the difficulties in the way of gas undertakings adopting the bye-product oven system. At the same time he submitted some supposititious figures, showing a balance of saving in working costs on the side of coke-ovens; and he believes that some half-way house will be found. We had it from Mr. Leather that a carbonizing temperature of 1400° is the one to give the best results both in quality and quantity of product. Mr. Allen challenged the figure given by Mr. Schlicht as the labour charges for retort work, and informed that gentleman that by machine work coke-oven costs had been attained in certain well-known gas-works. Where the bye-product coke-oven fails is, according to Dr. Colman, in not securing the right conditions for the travel of the gas through the charge. In the case of the vertical gas retort, the gas travels from the outside to the centre of the charge, and passes up the path furnished by the uncarbonized core of coal. Mr. Schlicht created much amusement by the emphatic manner in which he replied, not so much to the discussion as to the paper by Mr. Bury. On to that temporarily luckless gentleman's head, he let fall a perfect avalanche of words in which metallurgical coke-ovens were crushed and bye-product, or (as he called them) "gas-coke," ovens were glorified in unmeasured terms.

**Popular Appointments.**

Hearty approval was given to the report of the Scrutineers. The name of the new President—Mr. W. Doig Gibb—was received with a round of cheering. Mr. Thomas Glover automatically goes up in the vice-presidency; and Mr. J. W. Helps is now his companion in that rank. The announcement that Mr. Helps had been put on the road to the presidential chair was hailed with much satisfaction. The other elections were also most popular; and especial applause was given to the report that Mr. S. Y. Shoubridge had had the temerity to take up the mantle that Mr. Helps, in passing from Hon. Secretary to Vice-President, is casting off. The names of the new honorary members—the President of the Société Technique du Gas, and Professors Harold B. Dixon and Arthur Smithells—were also greeted with warmth.

All associated with Dublin who had contributed to the prosperity of the meeting were thanked most cordially, and especially Mr. Francis T. Cotton, whose services will not be soon forgotten. Thanks were also accorded to the President, the Council, the Honorary Secretary, the authors of papers, the Scrutineers, and last, but by no means least, the ever-courteous and indefatigable Secretary—Mr. Dunn. All mentioned did their part well; and the Dublin meeting of 1907 will ever stand in eminent position in the records of the Institution.

## HOSPITALITY OF THE ALLIANCE AND DUBLIN CONSUMERS' GAS COMPANY.

### A Luncheon at the Exhibition.

A twelvemonth ago, when Mr. Francis T. Cotton invited the members of the Institution to visit Dublin, he did so in the name of the Chairman (Alderman W. F. Cotton, D.L., J.P.) and the Directors of the Alliance and Dublin Consumers' Gas Company; and he assured the members that the Board would extend to them a most hearty welcome. That the invitation and the promise were made in all sincerity, the members had abundant testimony before they had been long in the city; and the warm-heartedness of their hosts was crowned by the luncheon to which they invited the members on Wednesday in the Herbert Hall of the Irish International Exhibition. It was a magnificent function, and possessed several features which will be held dearly in memory. Good nature and enthusiasm were unbounded, not only between hosts and guests, but between the hosts and British guests on the one side, and the representatives of other great and friendly nations on the other. America, France, Germany, Denmark, and Japan, were all represented; and the representatives were most cordially welcomed, and courtesies were freely exchanged. There were Messrs. R. M. Searle and Paul Schlicht from America, M. Marquisan from France, Mr. Hayman—a Britisher, but for some years resident in Berlin as an officer of the Imperial Continental Gas Association, Mr. Irminger of Copenhagen, and Mr. Mizuta, an Engineer of the Tokio Gas Company. The gathering was therefore quite an international one, and we might say unique. Alderman Cotton gracefully fulfilled the duties of the chair as the head of the Gas Company; and three of his colleagues who supported him were Mr. J. Scallan, Mr. J. Fottrell, and Mr. H. Drummond. Mr. W. Murphy, representing the Executive Committee of the Exhibition, was also present; and on the right-hand side of the Chairman was the President of the Institution, Mr. Charles Hunt. Altogether there were about 280 guests.

After lunch, several toasts were submitted, and without exception they were all accompanied by musical honours. We had "The King;" and the expression of loyalty was of the best. Subsequently,

Alderman Cotton, who was received with ringing cheers, said the pleasant duty devolved upon him of expressing the hearty thanks of his Board and Company to the Institution for having visited Dublin. He was sorry he had no words at disposal adequate to convey the pleasure he felt and, might he say, his colleagues on the Board of the Company, at having this opportunity of meeting so many gentlemen of eminence in a profession which had made such marvellous strides within the past thirty years, and conferred such enormous benefits upon the public. He was confident that they would not cease in their efforts to raise the status of their great Institution to the eminence it was entitled to hold. He believed there was a great future open to the gas industry, and that it was only necessary for the members of the gas profession to put their shoulders to the wheel to bring it to a successful issue. They had in the Exhibition an opportunity of judging between gas and electric lighting. He thought they would all admit that the lighting by gas was much superior to its opponent. He had had a calculation made as to the cost of lighting the Art Gallery, which, as he presumed most of the members had seen, was lighted by electricity; and the result of the calculation was that producing the same amount of light from gas would not exceed a quarter the cost of electric light, although the calculation for the latter was based on 1d. per unit—a price at which it was impossible to produce it in Dublin. He would not detain the members longer, as he was sure they were desirous of having a look round the Exhibition. He would conclude by asking those present to drink to the prosperity of the Institution of Gas Engineers, coupled with the name of the President, Mr. Charles Hunt, who had given constant and unremitting attention to the business of the Institution during his term of office. Mr. Hunt's successful professional career was so well known that he need not dilate upon it.

Mr. Hunt, in response, said he felt it was a very great honour to be called on to respond to this toast on behalf of the Institution of Gas Engineers. "Sure," said he, "this is a mighty pleasant change from the morning's diversion." [Laughter.] Alderman Cotton had, in the commencement of his speech, thanked the Institution for having visited Dublin. He (the President thought the boot was on the other leg; and that the members owed many thanks to Mr. Cotton for having been the means of their coming to Dublin, and for his and his co-Directors' most generous hospitality on this occasion. The Chairman had referred in very kindly terms to the great benefits which had accrued to the gas industry from the existence of the Institution. It was not for him (the President) to sing its praises; but he felt bound to say there was a great deal of truth in what had been said. He was one of those who could carry their recollection back for perhaps more years than was sometimes good for their peace of mind; and he could remember the time when the gas industry was on a far different footing from what it was at the present time. The improvement during the last 25 or 30 years in gas manufacture and distribution had been very marked indeed; and he attributed the improvement in very great measure to the influence of their meetings, which had been the means of disseminating information upon all matters connected with the industry. In one respect also the improvement in regard to themselves had been very marked. He could recollect the time when their discussions were confined to almost a handful of members, and complaint was made that outside a certain circle, the members did not take any part in the proceedings. But the fault lay not with those who took part in the discussions, but rather with those who did not. Now, however, all this was changed; and the change in this respect was very marked indeed. He did not recollect a meeting which he had attended—and he had been present at a good many during the last twenty-five to thirty years—at which the discussions had been so well conducted and so comprehensive and to the point as they were that morning and the previous day. He ventured to say that should this improvement continue, the good that the Institution had done in the past would be as nothing to the good it would effect in the future. He desired here to acknowledge the great kindness of the Lord Mayor, in allowing them the use of his rooms at the Mansion House for Thursday night's reception. He (the President) should be much indebted to Alderman Cotton if he would kindly convey to his Lordship his personal obligation to him for his kindness in this matter. He had one more apology to make. Among the many superlative virtues possessed by the Institution of Gas Engineers that of invariable punctuality was not one of them. They had an appointment with the Executive Committee of the Exhibition the previous day at four o'clock. Unfortunately, they were unable to keep the appointment. He could only plead that, after an arduous morning's work (which occupied them until an advanced hour in the afternoon), it became necessary to refresh the inner man; and although they did all they could to expedite that most necessary work, the consequence was they were half-an-hour behind their time. The Chairman had alluded to the lighting of the Exhibition; and at the risk of trenching upon the province of the proposer of the next toast, he would venture to say that those present had never seen a finer exposition of what gas lighting was capable of doing. They all thought the exhibition of gas lighting at Paris was extremely fine; but, in particular, the outdoor lighting here was at least equal to that, if it did not excel it. He (the President) had had an opportunity the previous evening of making a comparison between the gas lighting and the electric lighting; and all he could say was that gas lighting was far and away superior.

Alderman Cotton proposed the toast of the "Irish International Exhibition." He referred to the very brilliant success achieved by the Executive Committee, and expressed most heartily the hope of success to the end.

Mr. W. M. Murphy, in reply, said the Committee not only welcomed the Institution, but they were indebted to the members for having made this an exceptional occasion by having left London this year—and the first time for many years—to hold their annual meeting in Dublin. He should like to say he was connected with electricity; but he did not hesitate to admit that in public lighting gas could do better than electricity.

The President said there was a toast that was not on the list, which he was sure the members would desire should not be overlooked. He had much pleasure in proposing prosperity to their very kind hosts, the Alliance and Dublin Consumers' Gas Company; and in coupling with that the name of the esteemed Chairman and Managing-Director, Mr. Alderman Cotton. In his welcoming speech at the opening meeting of the members, the Lord Mayor referred to the price of gas in Dublin, but he also paid a compliment to the Company when he said that no exception could be taken to the

illuminating power of the gas they supplied. He could not help thinking at the time of the persecution the Company had recently undergone at the hands of the Corporation for alleged deficiency of illuminating power; and he could only hope that his Lordship's observations would reach the proper quarter, and result in the withdrawal of these vexatious proceedings, which, he felt certain, had not been at all justified. They were all endeavouring to supply gas as cheaply as possible, in the interests alike of gas consumers and gas shareholders. Corporations and other local authorities were much mistaken if they supposed that it would be in the interests of the consumers to inflict upon gas undertakings these vexatious proceedings, especially as illuminating power was now of far less importance than heating value. Then with regard to Mr. Alderman Cotton, he was, as the members knew, an old gas man—not "old" in years, but old in experience. For many years Mr. Cotton's name had been as a household word among them; and the Alliance Gas Company had taken the lead in many important improvements in gas manufacture. He (the President) recollected the time of the last meeting of the Institution—or rather of the British Association of Gas Managers—in 1871. There was then in use in one of the Dublin works what he believed to have been one of the first examples of stoking machinery—Best and Holden's; so that the Company might be regarded as having been one of the pioneers of stoking machinery. He hoped prosperity would continue to attend the Company.

Alderman Cotton made hearty acknowledgment.

Mr. J. W. Helps said he knew that he was transgressing; but he was doing so in good company. The President had proposed one toast that did not appear on the list; he (Mr. Helps) ventured to submit another. If it were not proposed, he was sure everybody would say a great duty had been neglected. He really did not know what the members would have done had it not been for the great assistance rendered to every one of them by Mr. Francis T. Cotton, and the energetic way he had ministered to the general comfort. Having worked with Mr. Cotton, he very sincerely appreciated the great assistance he had rendered to them. He therefore asked those present to drink to his health.

Mr. Francis T. Cotton, in responding, said it was just about a year ago that, on behalf of his Chairman and Board, he asked the Institution to visit Dublin this year. He remembered the way they responded to the invitation; and he felt it was a duty and a pleasure imposed upon him to make the visit, so far as lay in his power, a success. It was very gratifying to him to hear the remarks made by Mr. Helps, and to note the manner in which those present had so kindly drunk his (Mr. Cotton's) health. He desired to take this opportunity of saying what great assistance he had had from members of the Institution, and the sound advice he had received with regard to the gas lighting in the Exhibition; and the carrying out of the Gas Section. He hoped the lighting and the Gas Section had met with the approval of the members, and that their opinion was it would further the interests of the gas industry. He might also say that he had met with a great deal of criticism; and reports were circulated, within perhaps the past four months, that there was to be no Gas Section and no gas lighting. The members could see for themselves how much reliance they could place on these reports. He should also say that, from the very start a year ago, his Chairman and Directors had given him an absolutely free hand—regardless of expense—to carry out the work as he thought best. It was true it had cost a lot of money; but to be enterprising money must be spent. The programme had been broken through twice already; and he claimed the privilege of breaking through it once again. This gathering was certainly unique. They had friends from America, France, Germany, Denmark, and Japan. They could not drink the healths of these gentlemen separately; but they would do so collectively.

Mr. Searle, in responding, alluded to the common endeavour of the nations now to more firmly establish peace. He acknowledged the heartiness with which he and his friends had been welcomed by the Institution and their friends in Dublin.

M. Marquisan remarked that the Société Technique du Gaz en France had appointed him to represent the Société at the meeting of the Institution of Gas Engineers, and to convey their best wishes for the prosperity of the Institution. They remembered that each time they had come to England—especially when, after their meeting at Boulogne, they crossed the Channel—they had received a most fraternal reception from their British colleagues. There were words that they had not only on their lips, but in their hearts, and those words were *entente cordiale*. He expressed the sentiment now very heartily; and to it he added his hope for the greatest prosperity of the Institution, and for the progress of the gas industry generally, and particularly in the fine city of Dublin.

Mr. Mizuta (Tokio) said he wished to tender his sincere gratitude for his reception, and for being allowed the privilege of hearing so many interesting papers that day. He had come from Japan to study the most up-to-date systems in British gas practice. He should like to take the opportunity of expressing his gratitude for the kindness received during the time he had been visiting British gas-works. The gas industry in Japan was somewhat primitive, but it would by-and-bye make progress with the assistance of their friends. He wanted the alliance of the gas industry as well as alliance politically.

Mr. Schlicht also expressed his great pleasure at being present on this visit to Ireland, to see the grand Irish International Exhibition, to attend the meetings of the Institution, and to enjoy the hospitality of the Alliance and Dublin Consumers' Gas Company.

Mr. Irminger also thanked the members, observing that the relations of Great Britain with Denmark were as good and firm now as they ever had been. They could never forget that the Queen of England came from Denmark. He would drink to the British nation; and would raise the same cry that was raised a thousand years ago "Hurrah!"

Mr. Hayman said he was an Englishman; but as he had resided in Germany for the last nine years, he could express a word of thanks for the toast on behalf of the gas profession of Germany. He thought he could say that in Berlin they had something they could show gas men; and if they would visit Berlin, a hearty welcome would be theirs.

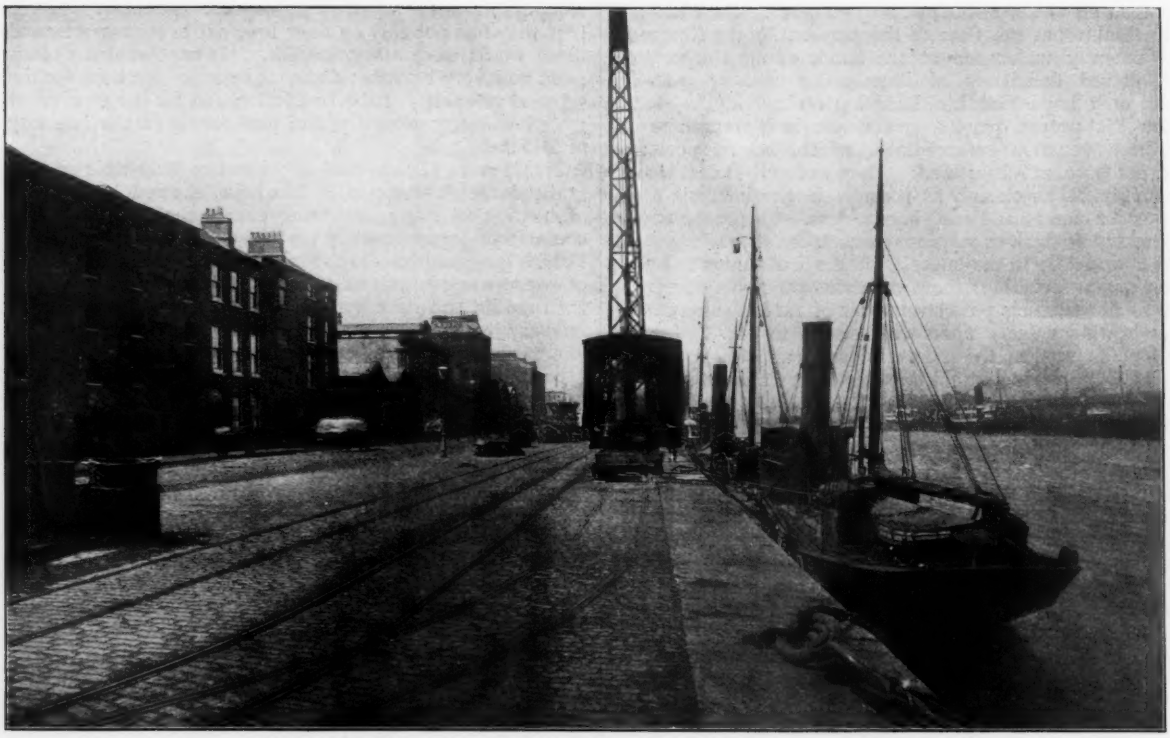
With the singing of the "National Anthem," the remarkable gathering separated.

## THE WORKS AND SHOW-ROOMS OF THE ALLIANCE AND DUBLIN CONSUMERS' GAS COMPANY.

### At the Gas-Works.

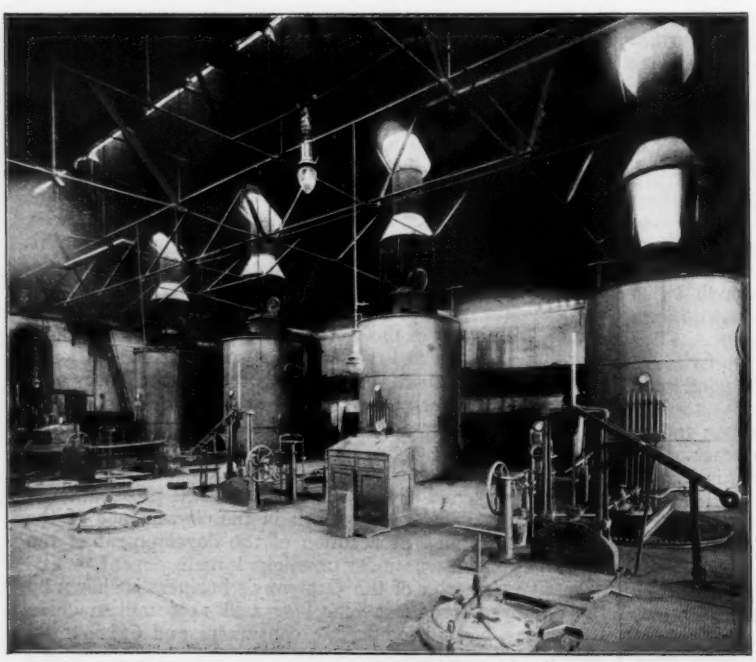
During the week, by the courtesy of the Chairman (Alderman W. F. Cotton, D.L., J.P.) and Directors of the Alliance and Dublin Consumers' Gas Company, the visitors to the city in connection with the meeting of the Institution were privileged to inspect the gas-works at Great Brunswick Street and the excellent show-rooms in Grafton Street. At the works the visitors were cordially received by the Chief Engineer (Mr. W. F. Cotton, jun., M.Inst.C.E.). Mr. Cotton is also a member of the Institution of Gas Engineers, and takes an active interest in the development of the Institution of Civil Engineers of Ireland, of which he is also a member. He is connected with many local institutions of a charitable nature, and is a J.P. of the city. When Mr. Cotton was otherwise engaged, Mr. G. F. A. Waterfield, the Assistant Engineer, took the visitors in hand, and showed them the plant, and explained their features. Mr. W. F. Cotton has been on the Company's works for upwards of thirty years, having formerly been assistant to Mr. E. H. Waterfield, who, for over forty years, was the Company's Engineer. On his death, Mr. Cotton, in the natural order of things, was appointed by the Board to succeed him; and his own engineering assistant is the son of the late Mr. Waterfield. No one knows the history of the works so well as Mr. Cotton, whose working life, man and boy, has been spent in them.

The works at Great Brunswick Street are the chief ones; but there are two smaller stations at Kingstown and Bray. We will not traverse the history of the Company, which has been a flourishing one. The present business is the product of the amalgamations of the original Companies who supplied the city, and of a close and determined prosecution of consumption development work in the city, in face of the equally determined prosecution of the development of the electricity business under municipal management. The extensive character of the Company's business is shown by the statement that last year they sold 1450 million cubic feet of gas, had 46,600 private consumers, and 6282 street-lamps. The distribution system is also the Chief Engineer's care; and in this he has to deal with 639 miles of mains.

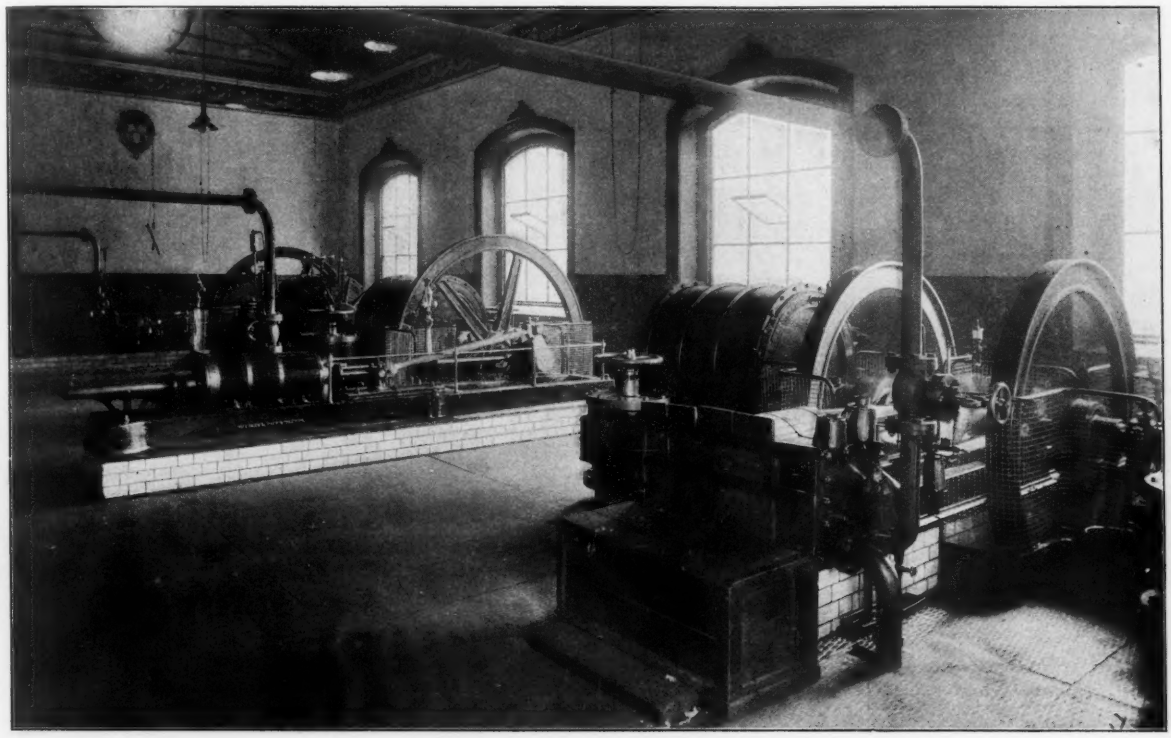


Sir John's Quay, where the Coal from the North of England is landed.

Treating briefly of the plant, the first thing to be noticed is that the Great Brunswick Street works are located on the Liffey; and to the works' quay the coal required for gas-making is brought by ship from Newcastle. Durham coal is used in Dublin, as a gas of 16-candle power has to be supplied; and that is 16 candles tested by a flat-flame burner. The whole system of testing is really unfair to the Company; and it is a pity the authorities do not recognize that it is a burden also upon the consumers. For, the lower illuminating power gas now sufficing for incandescent gas lighting, cooking, heating, and so forth constitutes an illuminating power and system of testing such as obtains in Dublin a positive piece of wastefulness, and a gross injustice upon the consumers, who, of course, have to pay for the excess illuminating quality that they receive. But we are now on the question of coal. The coal is unloaded from the vessels at the quay by means of cranes, trucked over tram-lines into store, whence it is carried to the retort-houses. This double lifting of the coal is somewhat expensive; and Mr. Cotton realizes that it is a weak point in the manufacturing operations. But the conditions at the works are rather against effecting any complete alleviation immediately. But already a scheme is in hand, as we saw from Mr. Cotton's plans, for alterations and improvements which, as opportunity permits it to be carried out, will effect the remedy. There are three retort-houses at the works. In No. 1, we find 28 beds of seven retorts, 20 feet throughs of ⏢ section 13 in. by 20 in. In the second house there are 19 beds of seven ovals—all throughs. In all these, each setting has its own furnace, and the regenerator principle is the vogue. The third house is the one that is especially interesting—not so much on account of what it contains, as because it is the scene of the commencing work in the improvement of the carbonizing plant and of the efforts to lighten the cost of coal handling. This house has been equipped with 37 ground-level beds of the old type, with coke removal by hand barrow—quite in the old-fashioned way. Half of the beds have been demolished; and during this summer, they are going to be rebuilt on modern lines, and the rest will be dealt with in due course. The new settings will be on the regenerative principle, nine retorts in a bed, and a furnace to each, with stage-floor. But hand stoking with scoops will be the system, as in the other houses. There are reasons why machine stoking is not used at the Dublin works. The Company and labour are on the best of terms; and the men at the works are reasonable beings, and are perfectly satisfied with the conditions of their employment. Machine stoking was tried some years since at the works, but was discarded; and the men now, rather than have machine work introduced, have offered and are willingly doing an extra seven retorts per shift (eight hours) for the same pay. Therefore the men themselves, by their reasonableness, are the obstacle to the Company adopting machine stoking; for from a financial point of view now, the Chief Engineer is of opinion that, for his Company (whatever it may be for other gas undertakings) there would be no advantage in changing from hand to mechanical working. In the reconstructed house, however, he is going to save the costly double handling of the coal



The Operating Floor of the Carburetted Water-Gas Plant.

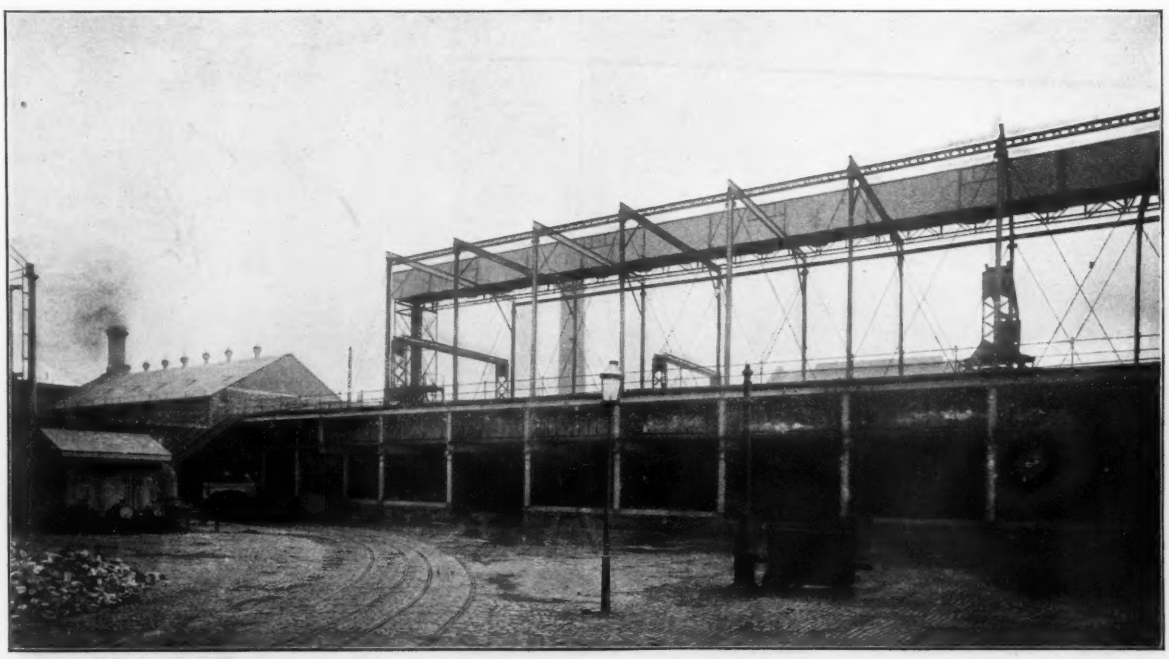


A View in the Engine and Exhauster Room.

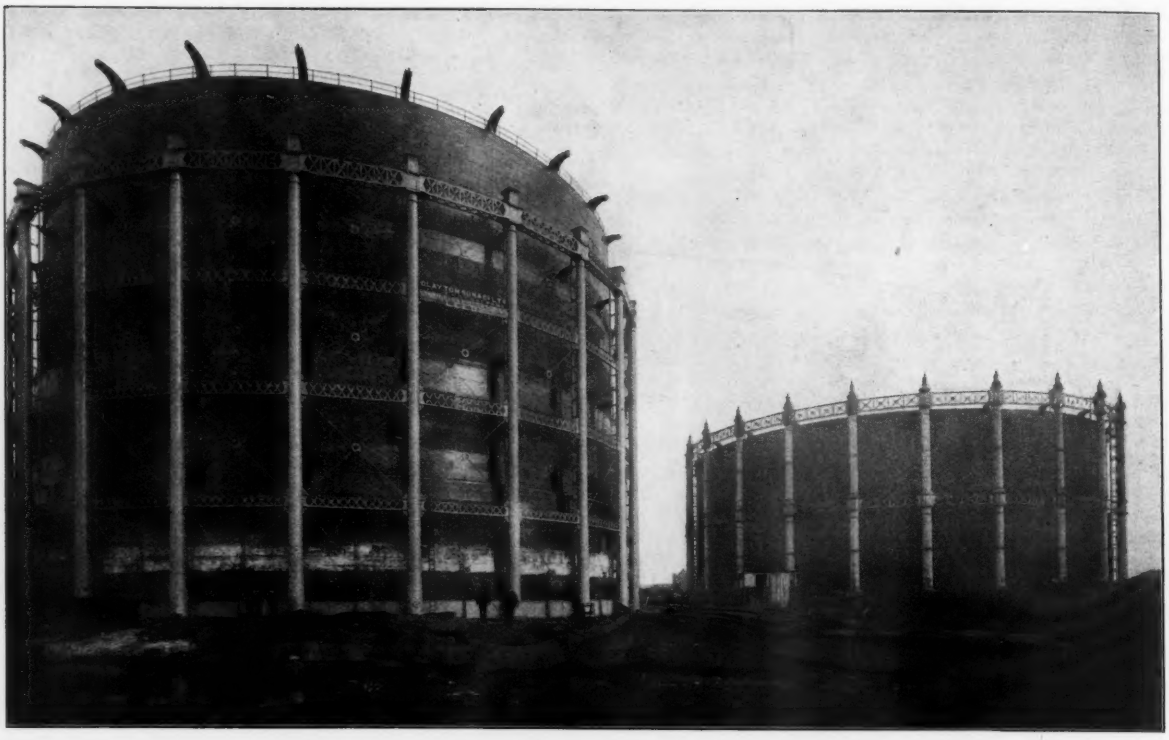
by putting in, not overhead hoppers, but side storage bunkers. These bunkers will be constructed along the sides of the house and down the centre between the two retort-benches—in this way (imagining a cross section of the house) there will be first a bunker 6 ft. 6 in. from the wall, then a 22 feet stage, a 20 feet retort-bench, a 22 feet stage, a central bunker 27 feet wide, a 22 feet stage, a 20 feet retort-bench, a 22 feet stage, and a 6 ft. 6 in. bunker against the other outer wall. It will be seen from this that Mr. Cotton has in this case a wide house with which to deal; and it has a three-span roof. These bunkers will stand on concrete foundations up to the stage-floors; and above the foundations they will be 36 feet to 38 feet high. Into these bunkers the incoming cargoes of coal will be unloaded direct The capacity of the bunkers will be some 5571 tons. The bunkers will be built of H iron, and 5-inch thick railway sleepers; such construction, while being strong, will be cheaper than any other form of construction of sufficient durability to answer the rough work to which they will be exposed. On the face of the bunkers, at the bottom, openings will be left so that the coal can automatically discharge itself on to the stage. This system of coal-handing is among the schemes for the future in connection with the other retort-houses.

There is also a retort-house at the Sir John's Quay end of the works containing 28 benches of seven ⏢ section retorts, each 13 inches by 20 inches. This house is also to be dismantled; and the Engineer will use the materials in his reconstruction scheme. The building will then be used as a reserve coal-store when the proposed new bunkers are full. The coals can be run into this store direct from the ships, and afterwards refilled by crane and grab. Its capacity will be 11,500 tons. Nos. 1 and 2 retort-houses will also, in their turn, be altered to settings of nine retorts to a bed, and be furnished with side bunkers. The coal storage available when all is complete will be 23,000 tons.

There is another feature about these works, and that is



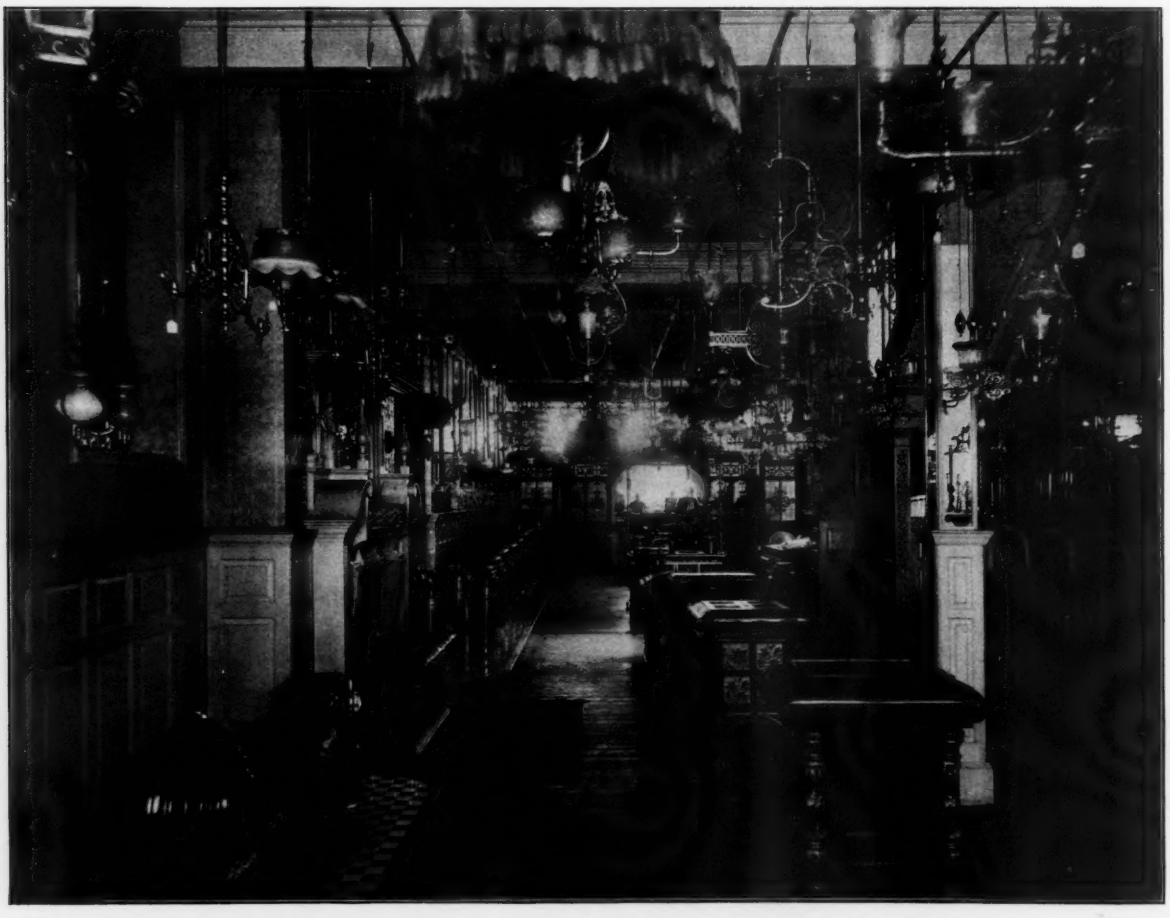
The Purifier-Shed—The Third Bay of which from the Right-Hand Side of the Photograph was the Scene of the Recent Fatal Gas Explosion.



**The Four-Lift Holder in a Tank previously containing a Two-Lift Holder.**

the system of coke removal and quenching. The coke simply falls through the stage-floors into iron carts (drawn by horses) of the ordinary wooden pattern, running in the basement. When there is a layer of about 6 inches of hot coke on the bottom of the cart, the men throw (say) a couple of buckets of water over it; and then quenching is finished when the cart is full. Mr. Cotton says the work is anything but laborious; and if the quenching is done systematically as explained here—quenching well the first portion of the coke falling into the cart—it is surprising how little water is really required for the work.

The coal gas producing plant is supplemented by four sets of Humphreys and Glasgow's carburetted water-gas plant; each set having a capacity of 1,200,000 cubic feet.



**The Grafton Street Show-Rooms of the Alliance and Dublin Consumers' Gas Company.**

From the gas-producing plant we have the usual run of apparatus to the holders. There is nothing special about it; but it is all capable of dealing with the maximum make of gas at the works. The maximum day's make up to the present has been about 8 millions. There is one thing that is particularly noticed; and it is that one of Dr. Harold Colman's cyclone tar-extractors has been applied, with a capacity for dealing with 7½ million cubic feet of gas a day. It has a good character here for efficiency. We were also interested in the purifier-house in which the lamentable explosion occurred some time since. It was seen that the Engineer has discarded electric lamps with flexible wires, and has gone in for hand lamps, fitted with storage batteries, for night-work. These will be fixed to brackets on the columns and walls. One of our illustrations shows the house.

There is another feature about the works which is peculiar in certain respects, and that is the quantity of work that the Company do for themselves, in providing tools, parts, rolling stock, and so on. Dublin is not London or other places within easy reach of great centres where everything that is wanted on a gas-works can be readily obtained; and therefore the Company have perforce (for convenience and economy, and also to keep work at home and give as much labour as possible to their own city) to do several things that are not customary in gas-works. Therefore many of the iron tools and other things required about the works are made here; and nice plant the Company have for doing the work. They have their own saw-mills, and produce, among their smaller work, the purifier-grids. But there is also work of a much more imposing order than this effected here. All the Company's waggons and hand-carts for the outdoor work are made on the works complete from tyres upwards; and beautiful specimens of work they are—in design, make, and finish. The Company are proud of this novel branch of their business; and certainly they turn out work that can be admired. While in the shops, an old type Crossley, 20-horse power engine, fitted with flame ignition, was found driving the machinery. It was doing its work in a comfortable and quiet fashion; and the character given to it is that it occasions no trouble whatever.

An interesting piece of work to which Mr. Cotton called attention is connected with the enlargement of a gasholder at Barrow Street (a short distance from Great Brunswick Street), which now ranks as the largest holder in Ireland. The work was carried out (to the specifications of Mr. Cotton) by Messrs. Clayton, Son, and Co., Limited. The holder occupies a tank built in 1870, which had contained a two-lift holder, with a capacity of 1,218,000 cubic feet. The new holder has a capacity of 2,900,362 cubic feet; so that the storage on the original area was increased by 138 per cent. In illustration of the great benefit this work has been to the Company, it may be pointed out that the total storage is now 27 per cent. greater than before, being increased by 1,682,000 cubic feet; and now an adequate pressure can always be commanded—it having been increased from 8 to 10½ inches. On the present occasion, we will not go into this piece of engineering work to greater extent, as there is in it the material for a special article on a future occasion.

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### At the Show-Rooms.

Eight years ago, in harmony with the more progressive policy the Gas Company had recently adopted, they opened a show-room in Grafton Street—the most fashionable street in Dublin for shopping. The premises were purchased, and the upper portion let; while the ground floor and basement were retained as a show-room for gas apparatus of every description for domestic purposes. It was a pleasure to visit the show-rooms; and the Company must be congratulated on their broad-minded and attractive treatment of them. We have to thank Mr. Francis T. Cotton, the Company's Secretary and General Manager, for his assistance in obtaining the particulars for this description.

The premises have a frontage of 25 feet, and a depth of over 100 feet. Plate-glass windows, neatly and lightly set in polished mahogany frame-work, display a choice selection of gas apparatus shown on a raised parqueted floor, bounded by a carved wood screen enamelled white, and carrying a yellow silk curtain to a height of about 4 ft. 6 in. The entrance porch is tiled in mosaic, with a neat device bearing the Gas Company's name. The show-room is panelled to a height of about 4 ft. 5 in., and then covered with Lincrustra Walton—the whole painted a creamy white colour, and having a mahogany shelf carried all round the room on the top of the panelling, forming a good place for displaying globes and other light articles. The room is 13 ft. 6 in. high. Sixteen mirrors, 6 ft. 6 in. by 3 ft. 9 in., are placed on the walls throughout the room, to brighten the general effect; and large framed photographs of special gas apparatus are hung at intervals.

At the extreme end of the show-room, a space of 25 feet is enclosed with an exceedingly pretty screen, bay-shaped, consisting of handsomely carved woodwork, carrying stained glass. This portion, originally reserved for office accommodation (since transferred to the stores and work-shops at Hawkins Street) is now utilized as a storage for pendants and other gas-fittings. In the centre of the show-room is a large brass plate, 6 feet high by 2 ft. 9 in. wide, containing 16 key-holes, so that any section of pipes throughout the building can be controlled without disturbing others. For instance, there are 150 pendants all different—and surely enough from which to make a selection—hanging from four rails run the entire length of the show-room, and gas can be cut off from either half of any one of these rails without affecting any other portion. There are also twenty brackets fitted up on the walls of the show-room. A handsome pedestal table, with polished mahogany beading and tiled top, carries a brass rail, which enables twenty more brackets to be displayed in action, and, in addition, 22 other burners of various types. A tiled recess, with a very handsome carved wood overmantel, contains a log gas-fire; and the brass club fender, with its upholstered seat of red morocco, gives an air of luxury. A bath is also fitted, showing three geysers of various types in action. On a raised tiled platform on either side of the show-room are displayed other gas apparatus. "Model" gas cookers such as are on hire are exhibited in action; and, connected to a special flue on the other side, are shown seven different types of gas-fires on hire. Dotted about the room are displayed to advantage goods from a 9d. boiling-ring to an expensive 10-foot range of roasters, hot-plate, and hot closet. Indeed, a would-be user of gas apparatus has an opportunity of selecting his requirements to advantage. It is altogether a well-appointed show-room, and one which is a model of completeness.

The basement is of the same dimensions as the ground floor show-room, and consists of a concrete floor, with walls tiled with Irish "opalite." It is used for heavy apparatus, and goods not usually required by the majority of callers; and every recess and corner is occupied by shelves to hold a large and varied stock of glass and other incandescent goods and fittings. The basement is lit by electricity, derived from a Crossley engine, with heavy fly-wheel, coupled direct to a Crompton dynamo, working at 250 revolutions per minute, at a voltage of 110.; and this serves its object of testifying to the efficient production of electricity by such means, if people will have electricity in big establishments. There is a large room used as a lock-up store for mantles, burners, and other valuable incandescent goods.

Outside the building, two ornamental cast-iron pillars, with special lanterns, are fitted each with a 20-foot Welsbach self-intensifying burner; and these compare very favourably with an adjoining electric arc lamp.

The show-rooms do not require a large staff, as they are used as a selection and order office only, where information and advice are freely given to consumers; orders being transmitted to the offices in Hawkins Street, which forms the chief point from which the stove and fitting department is conducted.

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## THE BENEVOLENT FUND.

The Annual Meeting of the Donors and Subscribers to the Benevolent Fund was held on Wednesday morning—the President in the chair.

The Hon. Secretary (Mr. Walter T. Dunn) having read the minutes of the last annual meeting, they were duly confirmed.

The President moved the adoption of the report and accounts, which were taken as read. He said it would be seen from the report that again the Committee had to state that the subscriptions amounted to a smaller sum than the expenditure. Had it not been for the interest on investments and special donations received during the year, there would have been a large deficiency. This showed that it was very incumbent on them to take immediate steps in order that they might increase the subscription list, and

thereby swell their permanent income. The appeal to the District Associations had not so far met with any very large response; but they were still hoping to receive some further subscriptions.

Mr. J. Hepworth (Edinburgh) seconded the motion. He said he could never quite understand why an appeal for subscriptions to this fund should fall upon deaf ears; but he hoped the Committee would go on urging the claims of the fund, because they all knew, from what the President had just said, that its outgoings were greater than the current means provided for. He could not believe that gas engineers were less responsive to an appeal for their poorer brethren than any other members of the community. He therefore trusted that the appeal would not be ignored, and that those who felt they could spare half-a-guinea or more would send it on to the Secretary of the fund.

Mr. D. Irving (Bristol) suggested that the President should call the attention of the meeting generally to the special needs of the fund. He said he was sure all that was required was to impress it upon the members, and that on the needs of the fund being brought before the members generally, it would meet with a ready response. The fact that there would have been a large deficit but for the special donation from the Earls Court Exhibition authorities ought to be specially emphasized. The President might also call the attention of the members generally to the very excellent and beneficial work that the fund, limited though it was, was doing.

Mr. J. Ferguson Bell (Derby), as one who last year drew the attention of the members to the very inadequate state of the fund, said he was very disappointed with the present balance-sheet. He felt sure that it only required to be brought prominently forward that the fund was in want of money for a large increase in subscriptions to result. In his opinion, the country ought to be districted out, and collectors appointed for the different District Associations. He thought the special donation of £50 ought to have been placed to capital account; and if this had been done there would have been a deficit. As it stood now, it looked as if there was a surplus.

The President said, before the conclusion of the meeting, he hoped to have an opportunity of mentioning the matter to the members, when it could be discussed generally. He thought that this would be a satisfactory way of dealing with the matter.

The motion was then put and carried unanimously, and the business closed.

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The Scrutineers of the ballot-papers reported that Mr. J. T. Jolliffe, of Ipswich, and Mr. Frank C. Taylor, of Shanklin, had been elected to the Committee.

## THE EXCURSIONS.

The excursions planned for Friday and the week-end were well patronized. There were three—the first being to Killarney (where the programme comprised the whole week-end and part of Monday), the second to Glendalough, and the third to Powerscourt Waterfall—the two latter being the Friday trips.

The party for Killarney, numbering over 70, started from Kingsbridge Station, Dublin, at 3 p.m. on Friday, and duly arrived at Killarney about 9.30. On Saturday morning the weather opened very bright, with showers. The party was divided into two for the Lakes and the Gap of Dunloe—each party traversing reversed ways. Unfortunately, the excursion was spoiled by the heavy rains on the Lakes and through the Gap, and everyone was glad to get back to the hotel—most of them soaked to the skin. The President and Mr. Francis Cotton accompanied the party; and the former looked perfectly happy on his "fiery steed" on his way through the Gap. Saturday evening the party indulged in a dance. Notwithstanding the misfortune in the matter of weather, the party were perfectly happy; and looked on the excursion as an everlasting memory of famous Killarney.

By common consent, the excursion to Glendalough or the Seven Churches (Co. Wicklow) on Friday was a decided success. While there was no sun, the weather remained fine throughout the day, except for the mile at the end of the drive. The members were therefore able to thoroughly enjoy the outing. Arriving at Rathdrum Station soon after 11.30, the party were driven in jaunting-cars through increasingly beautiful country, to Glendalough—a variation on the way being provided by a delightful walk through the Devil's Glen. Glendalough—"the glen of the two loughs"—is remarkable for its scenery and the ruins of ancient buildings known as the Seven Churches. Situated in a beautiful and picturesque vale, flanked on either side by mountainous country and with two small lakes in the vicinity, the spot was well worth visiting; but added interest attached to the excursion by the fact that at one time the spot was the site of a Bishop's see and presumably a city. The see is stated to have been founded in the seventh century by St. Kevin, and continued as a diocese up to 1214, when it was annexed to Dublin. The ruins of the Cathedral—a very small building—with those of various churches or chapels and a still existing Round Tower 100 feet high, attracted some attention. In consequence of the late arrival of the party at the Glendalough Hotel, only half-an-hour was available for visiting the ruins, and getting a glimpse of the lakes. The party then proceeded through picturesque country to Rathdrum Station, 9 miles distant, catching the mail train for Dublin, and arriving about 7.30, well pleased with the day's enjoyable and sociable outing. The party, numbering 80 to 90, were accompanied by the new President, Mr. W. Doig Gibb, of Newcastle-on-Tyne; the arrangements being looked after, with his customary care, by the late Hon. Secretary, and now Vice-President, Mr. J. W. Helps.

The excursion to Powerscourt Waterfall was very well patronized—47 making the journey. On alighting at Bray Station, jaunting-cars were in readiness to convey the members to Powerscourt Waterfall. The weather being favourable, the drive was most enjoyable. Several of the members, by special permission, were allowed to pass through the beautiful grounds of Sir Thomas Hudson. On reaching the main road again, the Sugar Loaf Mountain was passed; and proceeding through the Rocky Valley, Powerscourt Waterfall was reached, where a grand sight was witnessed—the falls, 300 feet deep, being in full flow. Returning through the private grounds of Lord Powerscourt, the party were driven past Powerscourt Hall on to Enniskerry. After lunch, a delightful time was spent walking through Dargle Glen; a further drive of 4 miles bringing the party back to Bray, giving ample opportunity for a stroll along the promenade. The return journey to Dublin completed what all agreed had been a glorious day.

## VISITS TO LOCAL WORKS.

The world-famed brewery of Messrs. Guinness, Son, and Co.—covering 50 acres, and dealing with 76½ million gallons of stout per annum—is probably always one of the sights of Dublin. Certainly, a large number of members and their friends were attracted to the works on Thursday afternoon, and had much to see in the very extensive and well-designed premises constituting No. 2 brewery. Assembling at the main entrance in St. James's Gate, the party was split up into contingents of about twenty. Each member was presented with a guide-book, and then conducted through the different departments. The various stages of manufacture were explained, as the brew-house proper, the fermenting house, storage, cooperage, packing department, and sampling-room, were successively visited. In the last-named room, the visitors were offered their choice of four different sorts of stout—foreign, export, extra, and single stout or porter. The magnitude of the works excited some interest, as indeed did the extent of the sales, which is such that no less a sum than £3000 per working day is paid by the firm for excise duty. The party finished up in the tea-room, where refreshments were enjoyed by ladies and gentlemen alike. For an interesting afternoon, the visitors were greatly indebted to the world-famed firm.

The same afternoon several members visited the Locomotive Works of the Great Southern and Western Railway Company, through the courtesy of the Locomotive Superintendent (Mr. R. Coey). They were very kindly received, and found much to interest them.

During the week, the works and show-rooms of the Alliance and Dublin Consumers' Gas Company were, by the kindness of the Chairman and Directors, thrown open to inspection. A special article on them appears elsewhere. At the Great Brunswick Street works, visitors were very courteously received by the Chief Engineer, Mr. W. F. Cotton, jun., M.Inst.C.E.; and at the well-appointed Grafton Street show-rooms, the attendants took pride in pointing out to visitors the features of the establishment.

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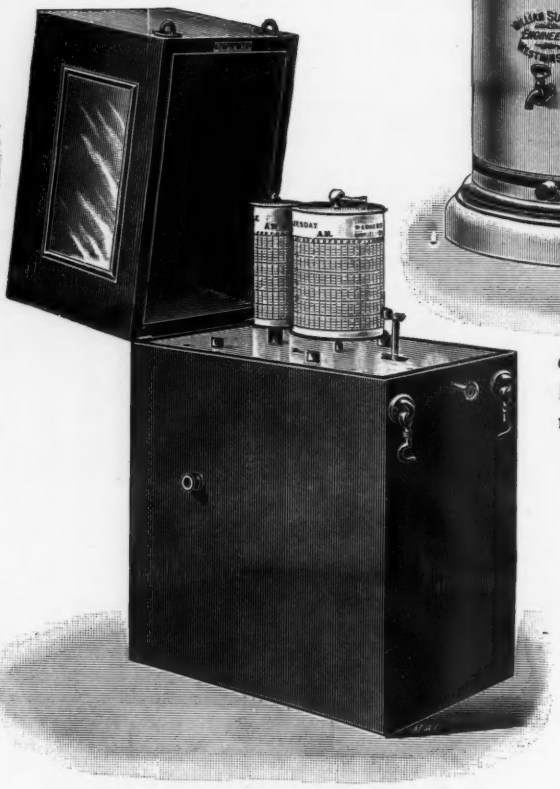

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# WILLIAM SUGG & Co., LIMITED, ENGINEERS, VINCENT WORKS, WESTMINSTER.

# GENERAL REPORT.

The Annual General Meeting of the Institution was held on Tuesday, Wednesday, and Thursday last, in the Lecture Theatre of the Royal Dublin Society, Kildare Street.—Mr. CHARLES HUNT, M.Inst.C.E., the President, in the chair.

### Welcome by the Lord Mayor.

The LORD MAYOR (Councillor J. P. Nannetti, M.P.), as Chief Magistrate of the City of Dublin, extended to the members of the Institution a hearty welcome. He trusted that the visit would be productive of much good to the organization, and also of advantage to the public as a whole. He was sorry the weather had not opened very well. But they must remember that every cloud had a silver lining; and he hoped before they went away their English, Scotch, Welsh, French, and American friends would have so far enjoyed their visit as to take back with them pleasant recollections of it. He knew that their deliberations were of a far-reaching and important character; and he would merely express the hope that, while everything that was done at the meeting would be of general advantage to the public, something would be done towards cheapening the price of gas in Dublin. A better system of gas supply and a better light could not be had; but the citizens felt the pinch when they came to pay for it.

The PRESIDENT thanked the Lord Mayor for his kind welcome. He said he had looked forward to the visit of the Institution to Dublin with pleasurable anticipations, which were already in course of being realized. He was sure the meeting would prove not only an enjoyable, but an instructive one. They could sympathize with the citizens of Dublin in their plea for cheaper gas. They were there to put to rights those who suffered wrong; and it was to be hoped that they might stay long enough to effect their purpose. It might be interesting to know that this was really the second visit of gas engineers to Dublin. In 1871, the then British Association of Gas Managers held their meeting in that very hall, and, as it happened, under the presidency of his immediate predecessor in the management of the Birmingham Gas-Works. It appeared that there were only four members present who also attended the meeting in 1871. He (the President) might claim to have been present on that occasion in the spirit, though not in the flesh, for his first contribution to gas engineering was then read. They looked forward with interest to the Exhibition which the enterprise of the citizens of Dublin had furnished for the visitors to Ireland during the present summer. He was sure the visit would be both instructive and interesting. He concluded by again thanking the Lord Mayor for his welcome.

The LORD MAYOR, in reply, said he was sorry to hear that there were only four members present of those who attended the former meeting. But he hoped that when the members came again, he should see all their faces, and that 36 years would not be allowed to elapse before that time arrived.

### Visitors from France and America.

The PRESIDENT announced that they were honoured by the presence of M. Marquisan, the Treasurer of the Société Technique, as well as of Mr. Schlicht and Mr. Searle, from America. The presence of these gentlemen gave quite an international character to the meeting.

### Confirmation of Minutes.

It was unanimously agreed that the minutes of the last meeting should be taken as read.

### Appointment of Scrutineers.

Mr. Charles Meiklejohn (Rugby) and Mr. C. F. Ruggles (Leighton Buzzard) were appointed Scrutineers of the ballot-papers.

### The Annual Report.

[See "JOURNAL" for June 4, p. 648.]

The report of the Council having been taken as read,

The PRESIDENT moved its adoption.

Mr. J. C. BELTON (Chester) seconded the proposition.

Mr. C. STAFFORD ELLERY (Bath) said he did not rise to offer any criticism on the report, but merely to ask a question with regard to one matter not referred to in it. The members were no doubt conscious of the fact that on the first of next month an Act of Parliament having reference to larger responsibilities with regard to workmen would come into operation. Would it not be possible for the Institution, through the Council, to do something to make the insurance of the men secure on more reasonable terms than hitherto? The more he looked into the terms offered by the various Insurance Offices, the more he was convinced that they were not only onerous but unreasonable. He remembered, when the original Act first came into operation, there was a discussion on the subject of the terms of insurance; and he believed it did good to this extent—that the terms upon which insurance could be effected were more reasonable afterwards than those at first offered. His mind was quite open in the matter; but he would suggest that something might be done by the Institution in so important a subject.

The PRESIDENT said the suggestion was a very excellent one; and he was sure the Council would desire to take the matter into consideration, with the view of seeing whether something could not be done.

The motion for the adoption of the report was then put and carried unanimously.

### The London Medal.

The PRESIDENT said the London Gold Medal had been awarded to Mr. Ernest Körting, for his paper read last year, entitled "The Vertical Retort from a Practical Point of View." He was sure it would be agreed that the Council's decision was a perfectly right one, and that there would not be the slightest jealousy in the minds of any of the members of the Institution that the highest honour that they had to bestow had been awarded to one who was not a native of these islands.

Mr. A. F. P. HAYMAN, of the Imperial Continental Gas Association, received the medal in the absence of Mr. Körting, who had sent his regrets at being unable to be present. He said Mr. Körting wished him to express his high appreciation of the honour conferred upon him, which he should look upon as an act of international courtesy.

### The Institution's Medals.

The PRESIDENT announced that the Institution's Silver Medal had been awarded to Mr. Charles Carpenter, for his paper entitled "Notes on the Argand Burner."

Mr. Carpenter was not present to receive the medal.

The PRESIDENT then presented to Mr. Thomas Glover, of Norwich, the Institution's Bronze Medal, for his paper on "The Retorting or Carbonization of Coal."

Mr. GLOVER returned thanks for the honour conferred upon him.

### The President's Address.

The PRESIDENT then delivered his Inaugural Address, which was given in the "JOURNAL" last week (p. 791). At its close,

Mr. T. J. REID (Ballina) said that he had been asked, on behalf of the Irish Association of Gas Managers, to propose that a hearty vote of thanks be accorded to the President for his very excellent and illuminating address. He did this with great pleasure, but at the same time he found himself wishing that he was possessed of the Lord Mayor's coach—not his Lordship's equipage, but the facile vehicle he employed to convey his thoughts. However, not being possessed of such a vehicle, he would do the best he could on foot. The address had been lengthy and very broad in its terms, and had covered every phase of the questions to be considered by the meeting. He was sure that, when the address came to be included in the "Transactions" of the Institution, it would not be considered the least interesting of their contributions. He wished to thank the Institution of Gas Engineers for the manner in which they had held out the hand of good-fellowship to the Irish Association. They had all probably experienced, at one time or another, that very happy feeling when they discovered that an act which had appeared to them to be commonplace had been deemed a virtue by others. When it was first intimated that the Institution were going to visit Ireland, a feeling of pleasurable excitement filled the breasts of the gas managers of the country; and they at once set about to see how they could best mark their great appreciation of the visit. While engaged on this very momentous question, the difficulty was solved by the Irish Association being invited to join in the meeting, which he considered a most generous act.

Mr. HENRY WOODALL, in seconding the vote of thanks, remarked that as he looked upon the President that day, he could not help recalling 21 years ago, when he occupied a similar position. He seemed not to have changed, except from one chair to another. He exhibited the same virility of mind and body now as then; and he (Mr. Woodall) was sure it was the desire of all present that the President should live long to possess the same qualities of mind and body. As the mover of the resolution had said, they had listened to a most illuminating address.

The vote having been unanimously carried,

The PRESIDENT, in expressing his thanks, said the members were indeed returning good for evil. He had inflicted on them a long address; and they had been good enough to testify their appreciation of it in the most kind terms. With regard to Mr. Reid's remarks, it had given the Institution great pleasure to have the co-operation of the Irish Association. He did not know what to say about Mr. Woodall's observations, except to return the compliment, and say he looked as young as ever.

### Reading of Papers.

The reading of papers was then proceeded with. They were taken in the following order:—

*Tuesday.*—"The Sale of Gas," by Mr. F. W. GOODENOUGH, of London. "Gas Consumption Development of Small Undertakings," by Mr. J. G. TOOMS, of Waterford.

*Wednesday.*—"High-Pressure Distribution Development in the United States," by Mr. ROBERT M. SEARLE, of Rochester (N.Y.). "The Testing and Hygienic Efficiency of Gas-Fires," by Mr. J. H. BREARLEY, of Longwood.

*Thursday.*—"Incandescent Gas Lighting, with Special Reference to Inverted Burners," by Mr. HAROLD E. COPP, of West Bromwich. "The Use of Tar for Roadways," by Mr. H. P. MAYBURY, of Maidstone. "The Financial Significance to the Gas Industry of the Modern Bye-Product Oven," by Mr. PAUL SCHLICHT, of New York. "The Use of Excess Gas from Bye-Product Coke-Ovens for Lighting and Power Purposes," by Mr. C. E. RHODES, of Rotherham. "The Carbonization of Coal, with Special Reference to the Bye-Product Coking Process," by Mr. A. N. BURY, of Little Hulton.

The papers, with reports of the discussions thereon, will be found in another part of the "JOURNAL."

### The Benevolent Fund.

On Wednesday, the annual meeting of the donors and subscribers to this fund was held; and a report of the proceedings will be found on page 911.

### A Visitor from Japan.

The PRESIDENT announced that they were honoured by the presence of a visitor from the Far East, in the person of Mr. Mizuta, an Engineer of the Tokio Gas Company. He had much pleasure in welcoming Mr. Mizuta to the meeting, and inviting him to come on to the platform.

### The Lecture.

On Wednesday evening, a lecture on "The Use of Gas from a Hygienic Standpoint" was delivered by Professor VIVIAN B. LEWES, F.I.C., F.C.S., and it will be found on p. 918.

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The members assembled at nine o'clock on Thursday morning. At the opening of the business,

The PRESIDENT read the following telegram from M. Payet, the Permanent Secretary of the Société Technique du Gaz en France:—

> Remerciements pour aimable invitation. Retenu à Paris. Regrette infiniment ne pouvoir me rendre maintenant à Dublin. Compliments et vœux pour succès meeting.
>
> PAYET.

### International Committee on Photometry.

The PRESIDENT said he had a somewhat important matter to bring before the members. It would be recollected that in the report of the Council there appeared a paragraph relating to the International Committee on Photometry, which he would read:

> On the recommendation of the British representatives serving on this Committee (Mr. Chas. Carpenter, Mr. James W. Helps, Professor Vivian B. Lewes, and Mr. T. O. Paterson), the Council have had printed and published in the Transactions of the Institution for 1906 a translation of the report of the Committee's first session, which took place at Zurich in June, 1903. Another session is to be held there in July next, which the Council have appointed Mr. Chas. Carpenter and Mr. James W. Helps to attend as representatives of the Institution.

It now transpired that the two representatives of the Institution were anxious to go to the conference armed with some authority from this meeting with regard to the standards of light which they were to support. The members would be aware that recent legislation had favoured the adoption of the 10-candle pentane lamp and the No. 2 "Metropolitan" argand burner. He was going to suggest to the meeting a resolution approving of these standards, in order that Messrs. Carpenter and Helps might go to the conference to support them. His resolution was as follows: "That this meeting is of opinion that the 10-candle pentane lamp and the No. 2 'Metropolitan' argand burner should be the recognized photometrical standard for gas under 20 candles."

Mr. W. R. HERRING (Edinburgh) said that he wished to suggest a slight alteration in the resolution. If the words "under 20 candles" stood, he would be cut out. He was anxious to adopt the standards in Edinburgh; and if the resolution were altered to read "up to and including 20 candles" it would meet his point.

Mr. J. W. HELPS (Croydon) thought, when the President worded the resolution, he had been rather guided by some information which he (Mr. Helps) had given him the previous day with respect to 20-candle gas. He had informed the President that it would not be tested with this particular burner, which he had been using for some considerable time, and very much admired. He had no objection to the resolution being amended in the way that had been suggested by Mr. Herring.

The PRESIDENT said he supposed it was almost a question of whether they should suit the gas to the burner or the burner to the gas. However, he would put to the meeting the amendment, substituting the words "up to and including 20 candles" for "under 20 candles."

The resolution, as amended, was carried unanimously.

### CONCLUDING BUSINESS.

Soon after midday on Thursday,

The PRESIDENT said they had now come to the end of their long list of papers; and he was sure the members would agree with him that the last of these had not been the least in value. They were very much indebted to all the authors of the papers; and at a suitable time he would endeavour to express his acknowledgments. Before commencing the concluding business of the meeting, he had to call upon Mr. Ellery to propose a resolution which he was anxious to put before the members.

### A Protest from Mr. Isaac Carr.

Mr. ISAAC CARR (Widnes) said before the concluding portion of the business was proceeded with, he might be permitted to make a remark on a motion he understood had been passed that morning. He had been given to understand that a motion had been submitted to the members present that morning of which no notice had been given on the *agenda*. He desired, on behalf of himself, who unfortunately was absent at the time, and on behalf of other absent members, to protest against any motion whatever being brought forward for the decision of the Institution, as to which there might be a diversity of opinion, without due notice having been previously given of it. He regarded the proceeding as altogether irregular and out of order. He did not wish to enter into the merits or the demerits of the question that was laid before the members. He submitted that the proceeding was irregular because it had not been notified in the proper way to the whole of the members, and, therefore, any decision that had been come to by the meeting that morning should be regarded as abortive.

The PRESIDENT said he was sure they were all very glad to welcome Mr. Carr to the meeting, even at the eleventh hour. He rather sympathized with him in his objection to the alleged irregularity of their proceeding that morning with regard to the resolution in question. The only thing he could do now would be to ask those present to pass a vote of indemnity. If the members thought that what had been done in getting the resolution passed without formal

notice was wrong, they would, he was sure, set him right. On the other hand, if he had done right, he asked for the members' assent. [Hear, hear.]

Mr. ISAAC CARR said this was no time to assent; and he submitted that the matter should be left open.

The PRESIDENT was quite willing to take the sense of the meeting upon it, and to accept it as the resolution of the meeting. He would ask for a show of hands upon the question.

Mr. J. C. BELTON said Mr. Carr was not aware that at the time the resolution was put to the meeting there was a much more representative gathering than at that moment.

Mr. ISAAC CARR said in any case he submitted that it was done without notice to the meeting, and therefore was irregular. He did not think that the President was entitled to put the motion to the meeting now. He submitted it was irregular, even now, to take the sense of the meeting.

Mr. D. IRVING (Bristol) said as the President himself admitted that, to an extent, the motion that was passed that morning was somewhat irregular, and as Mr. Carr was within his rights in making a protest, he thought it would be quite sufficient if the meeting were to pass the resolution now, so that they might get on to the next business. He was quite sure that Mr. Carr would be satisfied with having had an opportunity of making his protest.

The PRESIDENT asked if that was really the wish of the meeting. [Hear, hear.]

### The New Workmen's Compensation Act.

Mr. STAFFORD ELLERY (Bath) said he was much obliged to the President for the opportunity afforded him of bringing forward his motion. The matter he had to bring before the members was of such importance, and one upon which they would be so unanimous, that it would not require any remarks from him in support of it. They had now to face the new Compensation Act; and it seemed to him that the directors of gas companies very naturally turned to such a conference as was then assembled to see that the rights of gas companies were safeguarded. The present seemed to be a very fitting opportunity for them to use their collective power, whatever it might be, to investigate a subject such as this. Speaking for one company, he knew that they were looking to this meeting for some guidance in the matter of insurance. The President had been good enough to allow him to bring forward a proposition which he thought would meet the case of all gas undertakings. From conversations that he had had with gentlemen representing corporations, the subject was not of such pressing interest to them as it was to those who represented gas companies. The difficulty that some of them experienced was to know what should be the rate of insurance, and as to what was the real risk under the new Compensation Act. He did not propose to bring figures before the meeting; but he supposed other gentlemen had obtained tenders from Insurance Companies. To his mind, however, these tenders appeared so unreasonable that he thought the matter must be looked into by somebody—and who better than an Institution representing the gas industry? It was a large industry; and the amount of money paid by it for insurance was a very considerable sum. The Company whom he represented had, during the last six years, not received in claims anything like one-fourth the amount paid in premiums; but the present idea of the Insurance Company was to about triple the amount of the premiums. They would easily see how serious became this question of the insurance of their workmen under the Compensation Acts. He hoped he had said sufficient to justify his bringing forward his resolution, which was as follows:

> That, in view of recent legislation, the Council be requested to appoint a Committee to consider the question of insurance under the various Compensation Acts, and, if considered desirable, convene a conference of representatives of all the undertakings interested.

It was a non-committal motion; but he thought it would give them an opportunity of seeing how they were situated in the matter.

Mr. D. H. HELPS (Reading) seconded the resolution.

Mr. HERBERT LEES (Hexham) said it had occurred to him that every question touching gas administration was now asked to be referred to the Council of the Institution. He did not know whether the Council had sufficient time and funds at their disposal to warrant this; and it seemed to him that it should be done by the District Associations. In 1898, when the first Workmen's Compensation Act came into operation, similar steps were taken by his own Association. At that time the tariff offices asked very high terms. The Committee of the North of England Association considered the matter; and they got terms from the non-tariff offices. Eventually, satisfactory terms were arranged; but it was found that these terms were not sufficient to meet the risk now involved. It was true that in the case that Mr. Ellery had quoted for particular companies the terms more than covered it; but in the case of others they did not. In insurance matters, they must always take an average. It was found that the terms must go up to 7s. 6d. per cent.; and from information which he had received, this figure was found to be about correct under the old Act. But under the new Act the conditions were very different, and the terms were approximately as follows: To begin with, the tariff offices asked 17s. 6d. per cent., and the non-tariff offices went down to 12s. 6d. This was the lowest figure. But since then the tariff offices had come down. He thought that if the District Associations would work, either conjointly or separately, it might relieve the Council of the Institution. He had no objection to the resolution, except that he thought they were putting too much work on the Council of the Institution.

The PRESIDENT said that was a detail which might be attended to by the Council. If no one objected to the resolution, on the ground that no previous notice had been given of it, he would submit it to the meeting.

The resolution was passed unanimously.

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### The New Officers.

The SECRETARY announced the result of the election of office-bearers for the current year as follows:—

*President.*—Mr. W. Doig Gibb, of Newcastle-on-Tyne.
*Vice-President* (in association with Mr. Thomas Glover, of Norwich, elected last year).—Mr. J. W. Helps, of Croydon.
*New Members of Council.*—Mr. T. Berridge, Mr. Francis T. Cotton, Mr. W. Prince, and Mr. John Young.
*Auditors.*—Mr. James L. Chapman and Mr. Samuel Wood, F.C.A. (Messrs. Wood, Drew, and Co.).
*Hon. Secretary.*—Mr. S. Y. Shoubridge.

### Honorary Members.

The PRESIDENT said he had now the pleasure of nominating as honorary members of the Institution the President of the Société Technique de l'Industrie du Gaz en France; Professor Harold B. Dixon, F.R.S., of Manchester; and Professor Arthur Smithells, F.R.S., of Leeds.

Mr. SAMUEL GLOVER seconded the nominations, which were put to the meeting and carried unanimously.

### Result of the Ballot for New Members.

The SECRETARY announced that the Scrutineers had reported that all the candidates who had been nominated had been duly elected. The following is the list:—

MEMBERS.

Branson, A. W., Engineer and Manager, Rhymney and Aber Valleys Gas and Water Company.
Brodie, J., Manager and Secretary, Omagh Gas Company.
Browning, R. A., Engineer and Manager, Neath Gas-Works.
Edwards, H. G., Manager, Colombo Gas and Water Company.
Ely, W. H., Manager, Woking Gas-Works.
Hall, R., Manager and Secretary, St. Andrews Gas-Works.
Hoare, H., Engineer, Rockhampton (Queensland) Gas and Electric Lighting Company.
Keillor, G., Gas Engineer, Broughty Ferry Corporation.
Klumpp, J. B., Inspecting Engineer, United Gas Improvement Company, Philadelphia (Pa.).
Mackay, A., Engineer and Manager, Montrose Gas-Works.
Mackay, J. W., Deputy-Manager, Oriental Gas Company, Calcutta.
Mackenzie, J., Engineer, Newcastle (N.S.W.) Gas Company.
M'Leod, J., Manager, Gas-Works, Kirkintilloch.
Morton, A., Manager, Copiapo Gas-Works, Chili.
Potter, F. W., Assistant-Engineer, Shanghai Gas Company.
Reid, T. J., Engineer, Ballina (Ireland) Gas-Works.
Sainsbury, E. A., Manager, Holywell Gas-Works.
Shaul, E., Engineer and Manager, Penrith Gas-Works.
Thomson, W., Gas and Water Engineer, Ramsgate Corporation.

ASSOCIATE MEMBERS.

Baldry, H., Outdoor Superintendent, South Suburban Gas Company.
Booth, W. N., Assistant-Engineer, Huddersfield Gas-Works.
Chambers, C., Assistant-Manager, Harrow Gas-Works.
Gee, P., Assistant-Engineer, Pernambuco Gas Company.
Lyne, A., Assistant-Engineer, Wexford Gas-Works.
M'Gregor, A., Assistant-Engineer, Colne Gas-Works.
Randall, H. J., late Assistant-Engineer, Woodstock (Cape Town) Gas-Works.
Shadbolt, O. C., Assistant-Manager, Grays Gas-Works.

### Place of Next Meeting.

Mr. Alderman J. MILES (Bolton) proposed that London should be selected as the place for holding the next annual meeting. London was a place where they would be sure to get a very large attendance; and he thought, generally speaking, that it would be acceptable to the members.

Mr. HENRY HAWKINS seconded the resolution.

Mr. SAMUEL GLOVER suggested that the newly-elected President should be consulted on the matter.

Mr. DOIG GIBB returned thanks for his election as President. He hoped that the Institution would progress in the work that lay before it. As regarded the place for their next year's meeting, his own feeling was distinctly in favour of London. Newcastle was the only alternative; but, while they had an excellent meeting place in Newcastle, the lack of hotel accommodation, and of anything to be done in the evenings after business, rendered it a place which would not compare in any way with London, where everything could be obtained.

The resolution was then put to the meeting, and carried unanimously.

### Votes of Thanks.

The PRESIDENT then submitted the following votes of thanks: To the Council of the Royal Dublin Society, for permission to hold the meetings in their handsome Lecture Theatre, and for all the facilities afforded in connection with the arrangements. To the Alliance and Dublin Consumers' Gas Company, for their kind invitation in respect of their works and show-rooms, and for their kind hospitality. To the Right Hon. the Lord Mayor of Dublin (Councillor Nannetti, M.P., J.P.), for his kindness in lending the Mansion House for the purposes of the President's reception. To the Dublin United Tramways Company, for granting free passes for the use of the members during the meeting. To the Executive of the Irish International Exhibition for receiving the members and conducting them over the Exhibition, and for other privileges granted to members. To the Directors of Messrs. Guinness and Sons and the Great Southern and Western Railway Company, for permission to view their respective establishments.

Mr. W. R. HERRING (Edinburgh), in seconding the resolution, said it needed no words from him to commend the votes to the members. Their Dublin friends had been most kind, most hospitable, and most courteous to them all. They had enjoyed excellent accommodation for their meetings, splendid hospitality and kind welcomes, comfortable conveyance, and an excellent Exhibition; and those of them who were about to visit Messrs. Guinness's establishment that afternoon would probably enjoy something else.

The resolution was carried unanimously.

Mr. THOMAS GLOVER (Norwich) proposed that a vote of thanks be given to the Dublin Meeting Committee, and especially to Mr. Francis T. Cotton, for their valuable services in connection with the arrangements for, and during the progress of, the meeting. When, twelve months ago, it was first mooted that they should meet in Dublin, they were full of questioning as to whether the Institution meeting would be a success. They had had abundant evidence that the meeting had been a great success; and this was largely due to the very excellent arrangements that had been carried through by Mr. Cotton and the Committee who had worked with him. They were told that they would have a real Irish welcome—he believed that the Irish motto was "A hundred thousand welcomes." He had not been able to record whether or not that exact number had been given; but, taken altogether, they had had a very hearty reception. All the arrangements had been excellently carried out; and he was sure they had had a most enjoyable time.

Mr. J. FERGUSON BELL (Derby) seconded the motion, and said they would all take away with them very pleasant recollections of their visit to Dublin.

The motion was carried unanimously.

Mr. FRANCIS T. COTTON returned thanks forthe hearty vote just passed. He remarked that he was very proud a year ago when he heard that the Institution consented to come to Dublin; and he felt still prouder now that he had been able to do some few things for them during their visit. He thought it was an honour to be a member of the Institution; and he would always do his best to serve it in every possible way he could.

Mr. IRVING then rose to propose that the best thanks of the Institution be accorded to the President for his services in the chair, not only at the present meeting, but during his very arduous year of office. Mr. Hunt was an old parliamentary hand; and during a long and, he thought he might add, successful professional career, he had ever been ready to place at the services of his brethren his ripe experience and his eminent industry. Great things had been expected from Mr. Hunt; and he was sure the success of the meetings was very largely due to his experience and to his industry. He thought if they had any complaint at all to make, it would be that Mr. Hunt, with the energy and industry that were characteristic of him, had kept them there every day from morning to night with few exceptions. As far as he was able to judge, he had never known of any meeting outside London to be so successful as the present one had been. The success and the usefulness of these meetings were very largely due to the personality of the President. He would ask the members to join him in a vote of thanks to Mr. Hunt, not only for his services in the past, but for his intended hospitality that evening. The *conversazione* would bring to a close one of the most successful meetings that he could remember.

Mr. E. ALLEN (Liverpool), in seconding the resolution, said he would have to deny himself the pleasure of saying a great deal that he had in his mind to say. The subject was a very attractive one, and the proposer had spoken with great eloquence; but he had not quite done justice to the subject, and he (the speaker) should like to see if he could do better. Out of regard to the feelings of the members, however, he would content himself with saying how very heartily he seconded the motion.

The motion was then put to the meeting, and carried with the greatest cordiality.

The PRESIDENT said he came now to the most embarrassing moment of the last few days. He could not find words to express his gratitude for the kind way in which Mr. Irving had expressed the thanks of the members to him for what he had done to insure the success of the meeting. He owed a great deal to the gas industry—in fact, more than he could ever hope to repay. When he was asked to rejoin the Council a few years ago, he felt that he could not refuse. If he had done anything during his year of office to promote the cause of the industry and to advance the interests of the Institution, he was only too pleased; and he should be well repaid by their approval. He felt, as Mr. Irving had suggested, that he had been a little exacting on this occasion, but with the wealth of material which they had before them to discuss, he thought it would have been a shame if they had not devoted adequate time to it. It would have been unjust to the gentlemen who had been so kind as to furnish papers to the meeting not to have gone through them; and he thought they had reaped their reward in the time they had devoted to the papers. By a little self-denial that (Thursday) morning, they had been able to get through a long and, he thought, unprecedented programme. He was sure that the "Transactions" for the year would bear close scrutiny and study for a long time to come. He ought to say that he could not have got through the meeting in the way he had done had he not been so secure of the support of all the members. They had loyally supported him; and he would never forget it. He must also express his great indebtedness during his year of office to the assistance of their esteemed Honorary Secretary, whom they had just elected to the post of Vice-President, and whom he hoped they would one day see in the Presidential Chair; and he must further acknowledge his deep sense of indebtedness to the Secretary (Mr. Dunn), to whom he had been perhaps exceptionally troublesome, because he happened to be in close touch with him in London. Mr. Dunn had been of the greatest assistance to him; and he wished him many years of occupancy of his present office. He could only add that he was very much obliged to them all for their kind appreciation of his efforts.

Mr. JOHN BOND (Southport) said the authors of the various

papers had contributed to the "Transactions" of the Institution most valuable work. He was sure the members would take the papers to their respective homes and thoroughly digest them. He had great pleasure in proposing a vote of thanks to the readers of the papers.

Mr. J. T. Jolliffe (Ipswich) seconded the resolution.

The President, in putting it, said he must express his obligation to the readers of the papers for so kindly meeting the wish that he had to express in asking them to put the subject-matter of the papers before the meeting in as succinct a form as possible. This he was afraid had not done invariable justice to the authors, and he must ask their forgiveness for it; but it had not been possible to pursue any other course. If, however, the members generally would avail themselves of the opportunity they all had of reading the full text of the papers before coming to the meeting, no real injustice would ever be done in asking the authors to read a summary only of their communications.

The resolution was carried unanimously.

Mr. J. C. Belton (Chester) said it was his pleasing duty to ask the members to pass a hearty vote of thanks to the Scrutineers of the ballot papers and to the Auditors.

Mr. W. S. Morland (Gloucester) seconded the proposition, which was carried.

Mr. C. Stafford Ellery (Bath) said he thought they were too apt to look upon these resolutions as mere formalities. He was quite sure that their thanks in no formal manner were due to the Council for the work that they were doing for the Institution. He had had some experience of the work that had to be done; but what the past had laid on the Council was as nothing to what awaited them in the future. Those who read carefully the last report must feel that the Institution were now entering upon a new era. It seemed to him that the estimate which they, as members of the Institution, formed of the work would be in a large measure the estimate which their Companies themselves formed. They were asking them to subscribe funds; but it seemed to him that they ought in some way to be brought to realize the immense amount of good that was being done to the industry by these annual conferences, and by the work the Council were undertaking. The Companies were asked to find the money; the Council finding the brains. It seemed to him that many gas engineers might reasonably say that, considering the arduous duty attached to their work, they might be excused the gratuitous work of investigation. If it could be brought home to the Companies that they were benefiting in their pockets by the work that the members of the Institution were doing, their thanks would be of no formal nature. He thought that some very definite idea should be carried away to every town—both to their Companies and to their Corporations—that the Institution were deserving of all the support they could give for the sake of the industry. He coupled with his proposition the name of a gentleman who was very dear to the hearts of everyone. He had been looking at Mr. Helps and wondering whether he would like to say how many years it was since he first knew him. However, he would not give him away, he would content himself by saying that during the long number of years it had been a pleasure to him to meet Mr. Helps on every occasion; and he was quite sure that this feeling would be endorsed by every one of the members. He did not know that they could put into the office to which he had been nominated one who had better served the gas industry. He thought they ought to pass a hearty vote of thanks to the Council and to the Honorary Secretary, Mr. J. W. Helps.

Mr. E. A. Harman (Huddersfield), who seconded the resolution, said the Council were entitled to the wholesale thanks of the members. They all knew and respected Mr. Helps very highly; and they felt conscious of the difficulty in which he placed his successor.

The President, when putting the resolution to the meeting, desired to supply an omission of his own. He wished to acknowledge that during his year of office he had been most heartily supported by every member of the Council.

The resolution was put and carried unanimously.

Mr. Helps said, on behalf of the Council of the Institution, he had no diffidence whatever in thanking the members very heartily for the resolution so nicely proposed by Mr. Ellery and seconded by Mr. Harman. He knew how the Council had worked. They had met during the past year on a great number of occasions, and had sat in their meeting room for many hours; and he trusted they had done good work. He had some diffidence, however, when speaking to the part of the resolution which related to himself. He felt that he had somewhat neglected his duties. They would remember that at the last meeting—from circumstances over which he was not permitted to have any control—he was compelled to be absent the whole time. They would have heard from the President that during the past year his duties had not been of an onerous nature. Mr. Hunt had taken a great deal of the work off his hands. He had been in close proximity to their Secretary—in fact, almost next door—and the Secretary had had so many opportunities of meeting him and discussing matters with him that his (Mr. Helps's) services had not been required to anything like the extent they had been in past years. He wished to take this opportunity of thanking the members for the great honour conferred upon him in electing him a Vice-President. He looked upon it rather as an Irishman's rise, because he had so much appreciated the honour that had been done him in electing him to the office of Honorary Secretary that on leaving that office he was rather inclined to think that the position of Vice-President was not so important. He felt that he was leaving the office of Honorary Secretary in the hands of one who would be better able to fulfil it than himself. In Mr. Shoubridge they had someone who would look after the interests of the Institution better than he (Mr. Helps) had been able to.

Mr. Shoubridge thanked the members for the great honour conferred upon him in electing him as Honorary Secretary. He was conscious that the mantle which had fallen on him would be many sizes too large; but he was quite sure that his predecessor would help him to put it on. If he did not wear it with the grace that Mr. Helps had done, it would not be his fault; he would do what he could.

Mr. Helps next asked the members to pass a very hearty vote of thanks to the Secretary, Mr. Walter T. Dunn, for the work he had carried out. He had done everything to make them comfortable and to make the meeting a success.

Mr. Samuel Glover (St. Helens) had great pleasure in seconding the proposition. They owed much to Mr. Dunn for his continuous courtesy to the smallest of their wishes when they gave expression to them.

The resolution was put and carried unanimously.

Mr. Dunn thanked the members for the kind expressions used towards him, which, he said, he appreciated very highly. So long as he remained the Secretary of the Institution, the best services he could render would always be at the disposal of the members.

This terminated the proceedings.

## THE PRESIDENT'S RECEPTION.

On Thursday evening the social function of the week took place, when the President, with his two daughters (in the regrettable but unavoidable absence of Mrs. Hunt) received the members and their friends at the Mansion House, which was lent for the occasion by the Lord Mayor, Mr. Councillor Nannetti, M.P., who with the Lady Mayoress was present. The building contains a fine suite of rooms, and possesses not only a large concert hall, but a spacious circular room 120 feet in diameter, which served admirably for dancing purposes. The latter room is said to have been built in 1821 on the occasion of the visit of George IV. to Dublin, and is now used for festive and other public functions. The whole place was admirably suited for a reception such as that of last Thursday, though the very kindly welcome and hospitality of the host and hostesses were more than sufficient for the complete pleasure of those present. There have been many enjoyable gatherings of a similar character in the past; but the feeling of all—and there was a large number present—was that this will rank in memory with the best. It was a fitting *finale* to the series of the week's very successful meetings. The reception took place from 8 to 9 o'clock, and was followed by dancing in the Round Room, many joining in the dozen dances which formed the programme. Vocal and instrumental music was given in the Concert Room; and a large number found their pleasure there, particularly in listening to the singing of Miss Agnes Treacy. Refreshments were provided in the supper room. Before the party broke up soon after midnight, they sang "Auld Lang Syne"—the heartiness with which this was done, combined with the concluding cheers for the host and hostesses, evidencing the thorough enjoyment of all present. The acceptances for the reception numbered about 400.

# THE LECTURE.

## USE OF GAS FROM A HYGIENIC STANDPOINT.

**By Professor VIVIAN B. LEWES, F.I.C., F.C.S.**

I have so often and so forcibly advocated the hygienic claims of coal gas, that I confess to a feeling akin to despair when Mr. Dunn conveyed to me the mandate of the Institution that I was to adopt it as the subject for to-night's lecture—despair, not at the paucity of the subject, but at the difficulty of finding anything to say that had not been said before, and of suggesting new lines of thought and utility, without which the most brilliant lecture is of but little practical value.

### Products of Combustion of Gas.

The effect of burning coal gas as an illuminant on the air of our dwelling-rooms and the health of its occupants is as old a subject as the use of coal gas itself; and in the early days of the gas industry it threatened to wreck its future for indoor illumination, as the crude gas then sent out, rich in sulphuretted hydrogen, gave rise to such discomfort when consumed, that ventilating burners of clumsy device had to be employed for its use, while badly-made and leaky fittings gave at all times an aroma which suggested to the nose and mind of the householder a doubt as to the sanitary condition of the drainage.

A very short period, however, served to convince the gas manager that the purity of the gas was a matter of even greater importance to him than to the public, as the latter could escape the effects of the sulphurized products of combustion by adopting other illuminants; while the gas manager's livelihood depended on keeping his customers. As a result, purification from sulphuretted hydrogen was adopted, and the use of coal gas increased with enormous rapidity; the public being convinced by experience that, properly used, coal gas in no way injuriously affected their health.

With the advent of the electric light as an illuminant, great stress was laid upon its enormous advantages from the hygienic point of view; and its supporters still make the claim that it must of necessity be far more healthful to use as an illuminant than coal gas. It has not unnaturally been assumed that, owing to incandescent electric lighting adding nothing to the impurities in the atmosphere, and—what is quite as important—withdrawing no oxygen from it, it must be the most hygienic form of illumination to employ; but in the years which have elapsed since electricity was pressed into the service of man for illuminating purposes, it has become perfectly clear that, though it is inactive as regards vitiation of the atmosphere, a gas-lighted room will nearly always be more pleasant and healthy to live in than one lighted by the newer form of illuminant.

I have in my mind at the moment a hall, which in the old days was lighted by gas, and in which a large audience could with comfort sit through an hour's lecture or with pleasure through a three hours' dinner, but which, with the march of civilization, had its illumination changed from gas to electricity; the latter being employed with all the latest refinements to effect the lighting under the best conditions, with the result that any large gathering within its walls leads to a state little short of asphyxiation. It is with factors that lead to this anomaly that I now desire to deal.

Owing to the peculiar nature of the question, embracing as it does both chemical, physical, and physiological considerations, it is impossible to treat it from any one of these points alone; and, in order to make it clear, one must review the various data involved, although many of them are well known to you.

### The Constituents of the Atmosphere.

The atmosphere is composed mainly of two elementary gases—oxygen and nitrogen. The oxygen is the great supporter of life and combustion, and is the agent employed by Nature in those cleansing processes chief among which is "decay;" while the nitrogen serves to dilute the oxygen, and keep its action within the proper limits. These two gases are present in the air in the proportion of 20·9 per cent. of oxygen to 79·1 per cent. of nitrogen by volume, or, roughly, 1 volume of oxygen to 4 volumes of nitrogen. Besides these, however, we find in the atmosphere traces of other bodies, some of which, like water vapour, carbon dioxide, and ammonia, are necessary for the carrying on of Nature's processes; while others are the true impurities, and generally have a local origin.

The oxygen used up daily by processes of animal life, combustion, and decay, amounts, according to the calculations of Faraday, to no less than 3½ million tons; and it is replaced in the atmosphere by the products evolved by these actions—namely, water vapour and carbon dioxide. Yet analyses continued over the past hundred years have failed to detect any diminution in the quantity of oxygen or increase in the amount of carbon dioxide; so that it is manifest that Nature must have at hand some method not only for the removal of carbon dioxide from the air, but also for the production of oxygen, as otherwise the atmosphere would rapidly deteriorate and become unfit to support life.

The main factor in this marvellous natural work is to be found in vegetation; the waste products from the animal world being utilized for building up the vegetable kingdom—an action by which the oxygen is replaced in the atmosphere, and keeps it in a condition fit for breathing, while other impurities are partly washed out from the air by rain, and partly oxidized and destroyed by ozone. The wonderful power of diffusion possessed by gases is the chief factor in keeping the composition of the atmosphere constant, as, aided by air currents and wind, it keeps the whole of the gases present so thoroughly intermixed that it took scientific observers half-a-century to discover whether these gases were really only mixed together in the atmosphere or in chemical combination.

In the open air these provisions of Nature are ample to maintain the air in a healthy condition for breathing; but it is when we are in an enclosed space, such as a room, that we interfere with the work of purification, so that the air in the room rapidly becomes fouled by the products of respiration, and unless we take special means to aid Nature in the revivification of the air, it rapidly becomes unfit to be re-breathed, and our health suffers in consequence.

One of the most wonderful of the many marvellous processes taking place in our bodies is that which really forms the great mainspring of life. We build up our bodies from the foods and liquids which we assimilate, and the tissue so produced is then consumed in the body by a process of slow combustion taking place at the expense of the oxygen which, inhaled into the lungs, is carried by the circulation of the blood throughout the body, and, burning up the tissue, generates the energy needed for every action, voluntary or involuntary, and gives the warmth to the body which exists while life lasts.

### How Air is Contaminated.

The products given off during the process of respiration are carbon dioxide, exhaled from the lungs as we respire, water vapour, and traces of organic matter; and air which has been once breathed is unfit for further respiration until Nature has dealt with it by her cleansing processes. The air in the country contains on an average 3 parts of carbon dioxide in 10,000, while in towns the proportion is generally 4 parts in 10,000; and the latter figure is usually taken as the proportion present in normal air. In a room, however, in which people are breathing the air, the amount of carbon dioxide will increase; and when it has reached 6 parts in 10,000, the atmosphere of the room will become noticeably fouled to the nose of an observer entering from the fresh air, and is what we call "stuffy." This is due to the presence of organic matters evolved from the skin and lungs during respiration, and not to the slight excess of carbon dioxide, which is absolutely harmless; but the organic matter is excessively deleterious to health, and, moreover, often contains the germs of disease. When produced in this way by respiration, the proportions of carbon dioxide and organic matter increase at the same ratio; and as it is fairly easy to estimate the amount of carbon dioxide in the air, and extremely difficult to determine the organic matter, the condition of the atmosphere in enclosed spaces is generally investigated by determining the percentage of carbon dioxide present. The sanitary limit allowable has been taken at 6 volumes of carbon dioxide in 10,000 of air. But though this is perfectly correct when the source of pollution is respiration, yet the proportion may be far higher when the carbon dioxide is generated by processes of combustion without injuriously affecting health.

In the ordinary dwelling house, the attempts at ventilation are of the most primitive and inefficient character; indeed, in the majority of households the efforts of the inhabitants seem to be directed to getting the rooms as nearly

air-tight as possible, in order to make them warm. This, however, soon serves to render the air so vitiated as to be unfit for breathing. In the course of ten hours a man breathes out 6 cubic feet of carbon dioxide; and as the air already in the room contains 4 parts of this gas in 10,000, in order to reach the sanitary limit he can only add 2 parts more to each 10,000 parts of air. In the ten hours, therefore, he must be supplied with 30,000 cubic feet of fresh air. In other words, if the air of a room be not changed, it must be of sufficient size to contain 3000 cubic feet if it is to be inhabited by him for one hour; while in the case of a bedroom in which he is to spend seven hours, it would have to be of 21,000 cubic feet capacity. This is manifestly an impossibility; therefore arrangements are made by which the air in a room can be constantly changed. As this can be done three or four times in an hour without creating draughts, the air supply can be diminished to from 750 to 1000 cubic feet per inhabitant per hour in rooms which are to be occupied for any length of time; and this is the basis on which the ventilation of properly constructed buildings is arranged.

It is the organic matter given off from the lungs and tissues during respiration that it is essential to remove from the air; and before one can condemn the atmosphere in an enclosed space by mere analysis, the source from which the carbon dioxide was produced must be known, as without the presence of the organic matter it is possible to live in an atmosphere containing 20 parts of carbon dioxide in 10,000 without injury to health.

In all processes of ventilation, the great factors which enable us to change the atmosphere in our dwelling-rooms are the air currents set up by alterations in temperature and inter-diffusion between volumes of air at different temperatures; and it is this which gives coal gas its great advantages as an illuminant over electric lighting. The combustion of one cubic foot of coal gas will use up 6 cubic feet of air; giving approximately half-a-cubic foot of carbon dioxide and nearly 1½ cubic feet of water vapour. Using an incandescent mantle on an atmospheric burner, about 4 cubic feet of gas per hour are consumed; and this gives 2 cubic feet of carbon dioxide, which would very soon suffice to raise the proportion of carbon dioxide above the sanitary limit of 6 parts in 10,000. But though everything be done to render the room as air-tight as possible, it will be found that the proportion of carbon dioxide is enormously less than it should be by theory; this being due to the fact that alterations in the temperature of the air of the room set up currents and actions which tend to bring about a change of the atmosphere.

### The Value of Diffusion.

Carbon dioxide is a gas considerably heavier than air; so much so, indeed, that it can be poured from one vessel to another almost like a liquid. But, like all other gases, it is expanded by heat; and as the foul air coming from the lungs, and containing some 5 per cent. of carbon dioxide, is at practically the temperature of the body—*i.e.*, 98° Fahr.—it at once rises towards the ceiling, while the products of combustion from the gas-burner, being at a still higher temperature, also rush up to this point, so that the foul air is always to be found at the top of the room. One might think this foul air when cooled down would descend into the room again. But here comes into play the process of diffusion—a process by which gases, instead of arranging themselves, like other forms of matter, according to their weight, undergo a mingling or diffusion, the rate of which is dependent upon their weight; a light gas mixing rapidly with others, while a heavy one diffuses more slowly. It is found that, once mingled, the gases remain in perfect admixture; so that in the present case the heavy carbon dioxide will not again separate from the air into which it has become diffused.

This so-called diffusion of gases can be, and is, experimentally shown in many ways, and will take place with even greater rapidity through porous solids than when the gases are left simply in contact with each other; and as the plaster of the ceiling and the bricks or other building material of which our walls are composed are full of minute openings or pores, they allow gases to diffuse through with considerable rapidity—the force of diffusion being aided by a second force called capillarity. The result is that, even though the ventilation of a room has been neglected, and no proper outlet has been arranged at the top for drawing off foul gases, diffusion through the ceiling and the walls in the upper part of the room provides so rapid an egress for the hot gases, that they have not time to mingle with the air in the lower portion of the room, while fresh air is being constantly drawn in through every crack and crevice left by the jerry builder.

### Gas as an Aid to Ventilation.

An interesting series of experiments which I have made shows conclusively that, taking an ordinary dwelling-room lighted by gas and then the same room lighted by electricity, the air of the lower portion of the room, if one or two people only are present, is as pure with gas lighting as with electric lighting; while if a large number are present, the advantages are enormously in favour of gas—the air with electric lighting becoming rapidly so organically impure as to be positively dangerous to health.

*Distribution of Carbon Dioxide in the Air of a Dwelling-Room (Capacity 2700 Cubic Feet) with Gas and Electric Incandescent Lighting.*

Gas Lighting.

Two Welsbach "C" burners (on pendant), each consuming 4 cubic feet of gas per hour, and giving 140 candles.

| | Carbon Dioxide, Parts per 10,000. | Temperature, Deg. Fahr. |
|---|---|---|
| Outside air | 0·03 | 61·0 |
| Between joists | 0·06 | 66·0 |
| Ceiling level | 0·44 | 74·7 |
| Breathing level | 0·05 | 63·0 |

Electric Lighting.

Three 16-Candle Power Incandescent Lamps.

| | Carbon Dioxide, Parts per 10,000. | Temperature, Deg. Fahr. |
|---|---|---|
| Outside air | 0·03 | 61·0 |
| Between joists | 0·04 | 61·5 |
| Ceiling level | 0·09 | 62·5 |
| Breathing level | 0·06 | 61·7 |

If a number of people are in a room, the organic exhalations as well as the carbon dioxide and water vapour evolved during respiration rise, and, reaching the level of the gas-burners, are rapidly swept up to the ceiling by the rush of hot gas from the burner—the flame and heat destroying and charring a large proportion of the germs. The hot air reaches the ceiling, and diffuses through the plaster and walls in the upper part of the room; and in doing so the charred organic matter is left behind, filtered off on the surface of the plaster, and rapidly causes that discoloration of the ceiling which is invariably found in a town atmosphere above the gas-burner, and which is often wanting with country air. That this is the case is amply verified by the fact that if beams are present at the back of the plaster, diffusion is prevented at these points, and their position is plainly mapped out on the discolored surface.

When the room with its occupants was lighted by electric light, there was no rapid uprush in this way of the products to the ceiling; and the organic impurities and carbon dioxide leaving at body temperature remained diffused throughout the whole of the atmosphere of the room, causing a far more rapid fouling of the air and injury to health. If such a room were entirely left for its ventilation to diffusion through the walls, it would soon acquire that sour smell which is noticeable in many rooms of the poor, in which, in order to keep in the warmth derived from their own bodies, all ventilation is cut off. This smell is due to the decomposition of organic matter filtered off during diffusion by the wall surface and undergoing putrefactive decay, giving the offensive odour, the only way to get rid of which is to strip the paper from the walls and lime-wash them as well as the ceiling. Then, and then only, does the smell pass away.

When, however, this same diffusion through the ceiling and upper part of the walls of the room takes place in a gas-lighted room, this unpleasant human smell, so characteristic of the "tube" railways, is never detected, as the small quantity of sulphur compounds present in the gas (as was shown by researches of Mr. Otto Hehner and Dr. Rideal) is largely absorbed and fixed by the lime and lime salts present, and acts as a disinfectant, destroying all forms of germ life. Here, again, the hygienic superiority of gas is manifest, as in a gas-lighted room or hall not only are the germs present in the air, and often of an infectious character, destroyed and burnt up by the flame itself, but also undergo destruction and disinfection from the trace of sulphur dioxide present in the products of combustion—an action which is entirely wanting when the illumination is due to incandescent electric light.

An interesting point also brought out by the experiments

I have made is that it is really the position of the gas-light above the level of the head in the chandelier which causes this hygienic advantage, and that if the gas is burning in table-lamps the cooling of the products in their passage up to the ceiling largely does away with the ceiling action, and the air of the room may become as foul as when it is unlit, or lighted by electric light.

### Gas as a Fuel.

During the past twenty years coal gas has been making wonderful headway as a fuel; and the gas-fire and the gas-engine in many a crowded town help to decrease the smoke curse under which our big towns labour. Indeed, the convenience and cleanliness of the gas-stove is such an important factor in domestic life, that the use of gas for fuel purposes now is as valuable in the prosperity of gas undertakings as is its use for illuminating purposes. The only point that militates against it in the public mind is the assumption that it is much more expensive than solid fuel. But if we take into consideration all the conditions existing in our ordinary stoves and those to be found in the newer forms of gas-stove, experiment will soon show that this is not the case, and that the ratio of cost between the two largely depends upon the efficiency of the stoves used, and the way in which the heat is imparted to the air of the room.

Gas-stoves may be classified in three groups: (1) Flueless stoves, in which the products of combustion, either before or after condensation of water vapour, are discharged into the air. (2) Radiant-heat stoves, in which refractory bodies are heated to incandescence, and the heat is radiated into the room; the hot products and some unburnt gases escaping by a flue. (3) Stoves of the same kind as the latter, but in which, by means of air-chambers, regeneration, or passing the products through a length of metal pipe, most of the heat is withdrawn from the products of combustion before discharging into the flue. In the first class of stoves, all the heat of the burning gas passes into the air of the room, and practically the whole of the heating is done by hot air and convection; in the second class, the heat is mostly discharged into the room by radiation; while in the third class, both radiation and air-heating come into play.

### The Hygienics of the Gas-Stove.

There is not the slightest doubt, from a hygienic point of view, that heating by radiation is infinitely preferable to effecting the heating by warming the air; and this is one of the factors that make the English open fire so superior in comfort to the closed stoves and other air-heating devices so popular on the Continent. A good gas-stove, like the open fire, should not depend too much for its heating effect upon discharging warm air into a room, but should distribute a considerable proportion of its heat by radiation, and so raise the temperature of the floor and furniture in the lower parts of the room. Radiant heat does not directly raise the temperature of the air, but is radiated to the floor, walls, and furniture of the room, which again slowly part with their heat to the air in contact with them and to the inhabitants; so that the walls and other solid bodies in the room are at a higher temperature than the air.

Apart from its being much more healthy to breathe cool than hot air, there is another important point to consider. The normal temperature of the body, as already mentioned, is 98° Fahr.; and this temperature is maintained by the slow-combustion processes going on. By the laws of radiation, a heated body parts with its heat more or less rapidly according to the temperature of the surrounding bodies; so that if a person is sitting in a room filled with warm air, but near a wall colder than the air, his body will rapidly part with heat by radiation to the wall, and a sensation of chill will be the result. But with the open fire this is never the case, as the radiant heat from the fire warms the walls of the room to a temperature higher than that of the air. When, however, a room is heated by means of warm air, the walls not being heated in the same proportion, though the air may feel warm, the walls will remain cold; so that the heat of the body would pass by radiation to the walls, and give rise to a chill.

### A Protest Against Flueless Stoves.

Whatever views may be held on the subject, I feel very strongly that the idea that some forms of stove can be used without being attached to a proper flue is dangerous not only to health, but it also militates against the use of gas as a fuel, by encouraging the idea that gas-stoves are unpleasant and unhealthy as sources of heat. It cannot be too strongly insisted upon that a gas-fire, whether used for heating or for cooking, must be connected with a flue, as the products of combustion are just as deleterious, if not so dirty, as those given off by the combustion of solid fuel. I have on many occasions protested against the sale of flueless stoves; but I freely admit that, in spite of protests and preachings, they continue to flourish, and have indeed multiplied in number more than any other form of gas-heater. Some of these stoves are small ones of the ordinary types; while others, known as "condensing" stoves, are so arranged as to condense the water formed by the combustion of the gas, and the makers gravely assure the public that this removes all deleterious products. The popular idea of deleterious product is something that has an offensive taste or smell, or that in a very short space of time seriously affects the health; and if this view be accepted, then the makers of these condensing stoves have a modicum of truth in their statement, as the condensing water removes some of the products of the combustion of the sulphur in the gas, and where the gas used is exceptionally foul, this prevents a certain amount of discomfort. The ventilation of our rooms, however, is never too perfect during the periods that necessitate the use of the gas-stove; and the fact cannot be got away from that, for each cubic foot of gas burnt, half-a-cubic foot of carbon dioxide is formed, none of which is taken up by the condensing water. The gas, moreover, is discharged near the floor, and, being fairly cooled before leaving the stove, mingles with the air in the lower portion of the room, instead of rising, as do the products from an exposed flame, straight to the ceiling space.

A long series of tests made with these various forms of stoves shows, as might be expected, that with the flueless stove the whole of the heat finds its way into the room, and it did not in the least matter whether the gas was burnt in a flat-flame or a bunsen burner near the floor level, or whether it was consumed in a regenerator or condensing stove of the most costly and complicated pattern. In all cases the result was the same, and if the consumer does not mind hot foul air and injury to his health, a few bunsen burners low down in the room constitute the most effective form of stove that can be used. Indeed, this method of heating is, I am sorry to say, employed in certain popular restaurants. One of the commonest complaints against gas-stoves is that they "dry the air;" and this is entirely brought about by those forms of stove that heat the air, as by so doing they give it a greater capacity for taking moisture from the human body, and so producing a feeling of discomfort.

In the second class of stoves, which do the main part of their heating by radiant heat, and which, from the hygienic standpoint, are undoubtedly the best, it was found that only 35 per cent. of the heat was utilized in the room—the remainder passing up the chimney; while with the stoves fitted with air-chambers, regenerators, and other devices, naturally considerably more heat could be utilized.

### Conversion of Heat Units into Heat Radiation.

There is not the least doubt that, from every point of view, the best and most hygienic method of using gas for heating is the one which experiment has shown to be the least economical; and one of the most important problems in gas-stove manufacture is to find how far it is possible to convert the calories in the gas into heat radiations. In attempting to do this, considerable information can be gleaned from the theory of the incandescent mantle. The most valuable and complete research on the mantle is that by M. Charles Féry, published at the close of 1902. The conclusion he arrives at is that a mantle of ceria gives no light because it has so great a power of heat radiation that it is impossible to raise its temperature sufficiently in a flame (the temperature of which is limited by the phenomena of dissociation) to endow it with the power of emitting light. When, however, the ceria is sufficiently attenuated by subdivision in a thoria mantle, it can be raised to the required temperature, and the light of the Auer mixture is the result. In 1903, M. Saint-Claire Deville published some experimental results on mantles which led him to support the theory enunciated by Féry; and in January, 1905, in a lecture given before the Junior Institution of Engineers.*

* See "Journal," Vol. LXXXIX., p. 160.

I gave the results of a series of experiments which entirely endorsed this view, and which, as they have been overlooked apparently in recent work on the subject, I will again repeat.

When mantles of thoria, ceria, and various mixtures of the two are made of exactly the same size and shape (which can be done by using a Buhlmann burning-off apparatus), and when these mantles are tested in a properly regulated Kern burner, so as to avoid the use of a chimney, all conditions being kept exactly the same for each, it is found that the flame extends only 1 mm. or two beyond the mantle, and that the thoria and 99 per cent. thoria with 1 per cent. ceria are the only mantles that are heated to temperatures slightly higher than are found in the flame 1 mm. from the surface of the mantle. The temperatures of the mantle and flame, however, vary enormously with the character of the mantle; and the following table gives the mantle temperature and flame temperature taken 6 mm. above the rim of the burner—a point at which the mantle is just free from disturbing elements, and where the maximum light is being emitted. There is also given a relative radiation value for the mantles obtained by a thermo-pile placed at a fixed distance from them—all measurements being taken with every possible precaution to ensure accuracy. The thoria was not absolutely pure, containing 0·1 per cent. of ceria, so that the mantle gave 3·4 candles per cubic foot of gas consumed instead of 0·5; and this probably makes the radiation value higher, and the mantle temperature lower, than it would be for pure thoria.

| Mantle. | Thoria, 99·9 p. ct. Ceria, 0·1 p. ct. | Thoria, 99 p. ct. Ceria, 1 p. ct. | Thoria, 50 p. ct. Ceria, 10 p. ct. | Ceria. |
|---|---|---|---|---|
| Temperature of mantle 6 mm. above burner rim | 1610 | 1570 | 1335 | 1125 |
| Temperature of flame 1 mm. from mantle in same spot | 1590 | 1560 | 1350 | 1130 |
| Average temperature up to height of 52 mm. from burner. | 1468 | 1441 | 1209 | 1020 |
| Average temperature of flame over same zone | 1430 | 1439 | 1234 | 1032 |
| Illuminating power, candles per cubic foot of gas | 3·4 | 20·0 | 3·3 | Nil |
| Radiation value | 140 | 152 | 218 | 234 |

These experiments show clearly that thoria, with its low specific heat and low radiating power for heat, can be raised to the temperature of the flame; while ceria, by its excessive heat radiation, cools the flame and mantles.

As far as experiments have gone, ceria appears to be the body having the greatest power of heat radiation; and in order to gain an idea of the proportion of the calorific value of the gas used up, I have made experiments from which it was possible to compare the heat escaping from the products of combustion with the heat radiated by the heated body. Mantles of varying composition, but all identical in size and shape, were heated on a Kern burner, the consumption of which was kept constant at 4·6 cubic feet per hour. The gas used was that of the South Metropolitan Gas Company, having a calorific value, as determined in the Junkers calorimeter, of 137·5 calories gross. A mica chimney, 4 inches in length, was fitted into the aperture at the bottom of the calorimeter; and the burner and mantle were so arranged that the tip of the mantle projected half-an-inch into the chimney, so that readings of the radiation could be taken without the disturbing influence of any surrounding media; while the products of combustion practically all passed up into the calorimeter. The radiating value was measured by a thermo-pile placed with its face 1 foot from the centre of the mantle, and the following values were obtained:—

| | Calories. Gross. | Radiation. Value. |
|---|---|---|
| Burner without mantle | 107·6 | 23·5 |
| Pure thoria mantle | 94·5 | 74·0 |
| Ordinary Welsbach mantle | 91·9 | 79·0 |
| Mantle with 10 per cent. of ceria | 80 3 | 100·0 |
| Pure ceria mantle | 71·1 | 139·0 |
| Pure alumina mantle | 91·3 | 81·0 |
| "Sunlight" mantle | 90·5 | 84·0 |

These results show that the pure ceria, which has the highest radiation value, translates 48·2 per cent. of the calorific value of the gas into heat radiations; while with such bodies as alumina, which might be taken as representing very nearly that of the radiating power of the balls used generally in gas-fires, 33·6 per cent. is obtained—corresponding fairly well with experiments made on the best form of stove dependent for heating power on radiation only.

Experiments were then made with a fire-ball taken from an ordinary stove. This was heated in an atmospheric burner flame at a distance of 18 inches from the thermo-pile, and the radiation being determined, the ball was dipped in a dilute solution of cerium nitrate, re-ignited, and on testing as before was found to give an increase in radiation of 12 per cent.—an experiment which shows that it may be possible to improve, at any rate to this extent, the radiative power of the material heated in the gas-stove. I find that Mr. Edgar is making a radiating fuel on this principle.

Several interesting points were raised by Mr. Brearley's paper, one of which was that luting the gas-flue air-tight into the chimney space resulted in a lowering of radiant heat. The cause of this is evident, as an enormous amount of cold air is sucked in from the room over the surface of the incandescent material, which is cooled down at the expense of the radiant heat. Not only may the radiation be increased some 2 or 3 per cent., but gas-fires of this class may be made as important engines of ventilation as the open fuel fire, by making the short gas-fire chimney act like the gas-injector of a bunsen burner, and draw air from the room into the chimney, well above the fire itself.

### Defects and Advantages of Gas-Stoves.

The great fault with most of the stoves on the market is the high gas consumption—many of them using from 30 to 50 cubic feet of gas per hour; and this, by unduly swelling the consumer's gas bill, creates a prejudice against the use of gas as a fuel. But there is an immense future for a good stove consuming from 12 to 15 cubic feet of gas per hour; and advances are being made in this direction. In constructing gas-stoves, care must be taken not to cool the products of combustion too far before they discharge into the flue, as, if the temperature is reduced below the boiling-point of water, though a slight increase in heat is obtained, water is condensed, and, taking up the sulphur oxides formed from the carbon disulphide vapour in the gas, forms a highly corrosive liquid, which rapidly eats away the metal work of the connecting flue to the chimney, and corrodes the ironwork of the back of the stove.

Gas-cookers are daily becoming more firmly established; and the early prejudices against them having been overcome by experience, their convenience and economic advantages are leading to their almost universal adoption. But where they are extensively used, a ventilating shaft, with a good up-draught, should be in connection with a hood a few feet above the stove, as there is one phase in the use of gas fuel which should never be overlooked, and that is that if a cold substance, metal or non-metal, be placed in a flame, whether it be luminous or non-luminous, it will be observed that there is a clear space, in which no combustion is taking place, formed round the cool surface, and that as the body gets heated this space becomes less and less until, when the substance is at the same temperature as the flame itself, there is contact between the two. Moreover, when a luminous flame is employed in this experiment, the space still exists between the cool body and the flame; but it is also noticed that the luminosity is decreased over a still larger area, though the flame exists.

This means that in immediate contact with the cold body the temperature is so reduced that the flame cannot continue burning, and so is extinguished over a small area; while over a still larger space the temperature is so reduced that it is not hot enough to bring about decomposition of the heavy hydrocarbons, with liberation of carbon to the same extent as in the hotter portions of the flame. Inasmuch as, when water is heated or boiled in an open vessel, the temperature cannot rise above 100° C., and as the temperature of an ordinary flame is upwards of 1600° C., it is evident that the burning gas can never be in contact with the bottom of the vessel; or, in other words, the gas is put out before combustion is completed, and the unburnt gas and products of incomplete combustion find their way into the air, and render it perfectly unfit for breathing.

Experiments made several years ago on the gases escaping while a vessel of water was being heated from the ordinary temperature up to the boiling-point gave the following figures:—

| | Bunsen Flame. | | Luminous Flame. | |
|---|---|---|---|---|
| | Inner. | Outer. | Inner. | Outer. |
| Nitrogen | 75·75 | 79·17 | 77·52 | 69·41 |
| Water vapour | 13·47 | 14·29 | 11·80 | 19·24 |
| Carbon dioxide | 2·99 | 5·15 | 4·93 | 8·38 |
| Carbon monoxide | 3·69 | Nil | 2·45 | 2·58 |
| Methane | 0·51 | 0·31 | 0·95 | 0·39 |
| Acetylene | 0·04 | Nil | 0·27 | Nil |
| Hydrogen | 3·55 | 0·47 | 2·08 | Nil |
| | 100·00 | 100·00 | 100·00 | 100·00 |

It is quite clear that the extreme tip of the outer flame of the bunsen is the only portion that ought to be used for the heating; and if gas-cooker makers would only bear this in mind, and regulate the distance between the burners and the utensil to be heated, they would not only get a larger amount of heat, but would enormously increase the hygienic properties of their stoves.

At the close of the lecture,

The PRESIDENT (Mr. Charles Hunt) observed that those present had listened to a helpful and instructive lecture. He had much pleasure in asking Sir Charles Cameron to propose, and Mr. Herring to second, a vote of thanks, which he (the President) was sure the ladies and gentlemen present would be glad to pass.

Sir CHARLES CAMERON (Dublin City Analyst) remarked that there was a saying that history repeated itself. In a kind of promiscuous way, some years ago, he dropped into the large Concert Hall of the Royal University Buildings to hear a lecture. It was a very nice lecture; and he listened to it with a great deal of pleasure. At the end of it, he was asked to propose a vote of thanks to the lecturer; and he had been quite prepared to praise the lecturer—no matter what the lecture was really like. He was, however, greatly pleased when he found that his conscience was in no way violated by proposing a most warm vote of thanks to the lecturer, because he (Sir Charles) knew something of the subject himself, and the lecturer was eminently deserving of the most cordial thanks. That lecturer was the gentleman to whom they had been listening that night; and right glad he (Sir Charles) was that he had been able to attend. The first lecture was delivered many years ago; and he noticed some change in the Professor's appearance since that time. The learned lecturer had told them that an excess of oxygen would waste away the tissues so rapidly that persons became thin. He did not tell them whether the opposite was also true—that a slight deficiency of oxygen would increase those tissues. He thought the Professor must have been existing in a deficiency of oxygen; and that this had caused an increase in his specific gravity. Certainly, his specific gravity had increased by at least 25 per cent. However, he had been delighted in listening to the lecturer that night. He appeared to be as witty, and to have as great a command of words, as an Irish Member of Parliament. As an Englishman, Professor Lewes would take it that, in saying this, he (Sir Charles) was paying him a no mean compliment. As a scientific man, he had greatly admired Professor Lewes's experiments that night, and the graceful way they were all performed. In giving a lecture of this kind, he knew how difficult it was, away from one's own laboratory or lecture room, to have the necessary apparatus brought from a distant city, and arranged in a place where the lecturer was not accustomed to arrange the apparatus. Therefore, the more praise was due to Professor Lewes. With regard to the relative merits of electricity and gaslight, he did hope the day would come when the combustion of crude coal in their domestic fire-places would cease. He hoped that all coal imported to the city, before it was used in any way for domestic purposes, would be primarily treated at the gas-works. The quantity of coal used for domestic purposes produced immense quantities of sooty matter, diluting the air, lying above them like a dismal pall, and obstructing the life-giving rays of the sun. If this was done, if smokeless fuel from the gas-works, or the gas itself, was supplied to their fire-places, or by some ingenious process gas and coke could be used combined—and gas engineers were quite capable of showing how this could be done—they would, from the combustion of the two, produce an intense heat and little or no evolution of smoke.

Mr. W. R. HERRING seconded the motion, remarking that they were all indebted to Professor Lewes for his eloquent and able lecture. But he was afraid, if their wives were invited to these lectures in the future, they would suffer somewhat in their estimation. Professor Lewes had made much of the point that gas engineers knew little about their business. As a matter of fact, he could assure the ladies they knew every word Professor Lewes had uttered; and, in fact, they might have given him one or two hints how to explain the matter better to the ladies. [Laughter.]

The motion was carried by hearty applause.

Professor LEWES cordially thanked Sir Charles Cameron, Mr. Herring, and all present for the vote. He need hardly say that he felt very deeply the remarks of Sir Charles as to his "fairy-like" figure. [Laughter.]

## IMPRESSIONS AT THE EXHIBITION.

### A Remarkable Lighting Demonstration.

THOSE gas engineers who were unable to be in Dublin last week, and will not have an opportunity of paying a visit during the life of the Irish International Exhibition, will miss a remarkable lighting demonstration. There is much light to be obtained there—light for the eye, light for the mind, and light on the vain claims of electrical braggadocios for their well-beloved flame arc lamps. There the latter can learn, by direct comparison, that the flame arc has been trifling with and deluding them, and that, when brought into close quarters, on terms of nominal equality, with the latest forms of high-pressure incandescent gas lighting where the eyes can make an immediate estimation of relative values, the deception cannot continue.

People ask for an explanation of the difference between illuminating power and illuminating effect? Mr. Thomas Newbigging once attempted to define it; but his definition, good as it was, pales before the brilliant demonstration of his meaning at the Dublin Exhibition. Go into the Central Hall, and look up into the large dome. There are seen eight high-pressure gas-lamps. Every feature and every line of the dome and its windows stand out with striking sharpness; and the purity of the light is remarkable. Suspended from the ceiling in the space surrounding the dome are flame arc lamps. The ceiling is variegated by shadows and light, and its outlines and features are blurred—there is nothing distinct about them. The comparison is an excellent one; the contrast is so singularly pronounced that no one concerned in lighting matters can fail to note it without having special attention drawn to it. The eye is a competent judge of good lighting; and many must be the maledictions secretly hurled at those who were responsible for allowing such a disproof of the alleged superiority of the flame arc lamp to be made in the eyes of the people of Dublin and of the thousands upon thousands of visitors from afar who have been, and will be, visiting the Exhibition.

The eye we repeat is a competent judge of lighting; and opportunity for making further visual comparison is given in the grounds. The grounds between the main entrance and the central buildings are lighted by flame arcs. There are no grand shop windows here as in Oxford Street lending their friendly aid to the flame arcs. They have to stand on their own merits. Taking up a position in one part of this portion of the grounds, we see the end high-pressure gas-lamp in front of the Palace of Industry. There are three flame arcs close by—the high-pressure gas-lamp illustrates what is meant by light diffusion; the flame arcs what is meant by light concentration. Around the bases of the columns of the flame arcs, there is an abundance of light; but, beyond, we get the same ill-definition of buildings and other features of the scene that was observed in the central hall. There is no escaping this; and the electricians have to accept and acknowledge it. A gentleman who is identified with electric lighting was representing the Exhibition Executive Council at the luncheon given by the Alliance and Dublin Consumers' Gas Company to the members of the Institution of Gas Engineers last Wednesday; and he confessed that the demonstration left him no other course than to accept the truth that gas can beat electricity for outdoor lighting. We will not quarrel with him over his limitation of the region where gas is the victor; gas can take care of itself elsewhere. Anyway, the electricians are not elated over the part electricity is playing in the lighting at the Irish International Exhibition.

But turning from the examples of comparative lighting, to those parts of the grounds illuminated solely by high-pressure gas-lamps, tablets are found affixed to some of the lamp-columns, and on them is inscribed this notice: "This portion of the grounds is exclusively lit by gas supplied by the Alliance Gas Company, Dublin." If inquiry is made of Mr. Francis T. Cotton (to whose energy this grand illumination display is due), he will tell you that the notice was necessitated by the people of Dublin—not being accustomed to such a rich lighting spectacle—giving the Corporation Electric Lighting Department the credit for it. Therefore, although modesty forbade, defence of character insisted upon the public declaration. From the central buildings, through the Grand Avenue, and in front of the Palace of Industry gas has it all its own way, excepting in the decorative outlining of parts of the buildings by incandescent electric lamps, which do not lend any aid in the illumination of the broad

The Gas-Lamps Round the Band-Stand and in the Grand Avenue.

ways of the grounds. Here we have a splendid piece of gas lighting. The surfaces of the avenue and of the bye-ways are so well lighted that a fallen pin need not be passed by. There are no dark spots; the lighting enlivens the whole scene. Visitors pass through the portion of the grounds lighted by the flame arc lamps, and congregate and promenade here in the parts illuminated by gas. The verdict on all hands is that a better piece of outdoor lighting has never been witnessed. We have recently given some photographs of the Exhibition in the "JOURNAL," and we reproduce three of them; but they very inadequately convey the impression that the lighting made upon the visitors last week. Honour must be given where honour is due; but no distinction can be made between the excellent work in this high-pressure gas-lighting demonstration of Sugg and Co. and Keith and Blackman. They vie with each other for superiority in result; in the race, they are cheek by jowl. But while distributing honour, those firms would regard it as an act of omission on our part if we did not say that, in their efforts, Mr. Francis Cotton was an unfailing support.

The wrought-iron tube columns, with their ornamental cast-iron bases and ornamental wrought-iron swan necks or harp mountings on which the 1500-candle power high-pressure gas-lamps are suspended, look neat, and in perfect

The Lighting of the Grand Avenue by Gas.

harmony with their surroundings. As a matter of fact, they seem quite an essential part of the complete night scene. A few of the columns in special positions carry three and five lamps each of 1500-candle power. The distance from the ground line to the centres of the mantles is about 16 feet, with the exception of the raised centre lamps of the clusters. The gas is supplied, according to the system, at about 16 and 20 inches pressure. Altogether there are 208 high-pressure lamps (of course, not so many columns owing to the clusters); and the aggregate lighting power is 312,000 candles from these lamps alone. The order for the lighting was obtained from the exhibition authorities on the last day of February; and the first night of the exhibition, it was started without a hitch of any sort. Now that the result has been seen, much is expressed when we say, "Well done!"

Not only outside but inside the buildings, other than in the dome of the central building, gas lighting demonstrates its richness—the systems of lighting in use being provided by the Welsbach Company, Moffat's Limited, and Messrs. Anderson and Duffield, Limited. The Humphrey lamp is also testifying to its efficiency. In the buildings, the electric arc lamps find their efforts to please ineffectual against the beauty of the lighting by the gas systems. We do not mind, as the advertisement is good for gas, but really it is unkind of the exhibition authorities to have planned the lighting so as to completely expose the deficiencies of electric arc lighting. We hear a great deal about the safety, too, of the electric light. In the Art Section of the exhibition, in which there are pictures of immense value, the authorities have put in gas lighting as a precaution against the thieving of pictures in the event of the failure of the electric light.

What have we to say as to the Gas Pavilion? Much the same as of the lighting. By the photographs and general descriptions already published, we were deceived. From them, we had not expected anything extraordinary; the surprise is complete. All stands were in perfect order for the visit of the Institution. Everyone knows that it is not always large things that are the most valuable. There are small things that are rich and perfect. That is so of the Gas Pavilion at the Irish Exhibition. When we say "small," the term is used comparatively. The section is not so large as any one of those we had at Earl's Court; but it is not a local exhibition. Each and every one of the exhibitors have done well. They have not stinted their stands. They intended the thing to be properly done; and all honour and reward to them. We have already published their names (see "JOURNAL" for May 7, p. 360). They have given the public just what was required in all matters pertaining to incandescent lighting, heating, cooking, and the uses of gas generally, and manufacturing plant has representation. The compressing plant for the high-pressure gas lighting is also installed here. The suite of rooms fitted up by the Alliance and Dublin Consumers' Gas Company is another excellent and popular feature, displaying to all and sundry how rooms should be lighted and heated, and how labour in the house should be saved. A critical member of the Institution on the night of the official inspection by the President and members remarked to Mr. Francis Cotton, in whose company the writer happened to be at the time: "You have given just what was wanted here—not too much, but enough to be good. It is well done; and I must congratulate you." Such an impromptu testimony exactly expresses our views. Both the public and professional gas men cannot help being interested here. In this praise we are certain of the support of the members of the Institution who were in Dublin last week, and of the 110 ladies and other visitors, including welcomed members of municipal Gas Committees.

Adjoining the Gas Pavilion is a small separate building, in the sole occupation of Messrs. Mansfield and Sons, where they are showing their oil-gas apparatus, and the beautiful lighting effects obtained. It is claimed to be a compact plant, free of all complication, and will make gas from any kind of oil, fat, or grease for any commercial, domestic, or industrial purpose where light, heat, or power is required. The firm do not pretend that their system can compete with ordinary town gas; but they do claim that it is more economical than electric light, oil-lamps, gasolene gas, acetylene, or coal gas made by private plants. The plant simply consists of a producer and a small gasholder. The retort in the producer is heated by a coal or wood fire; and a strong red heat is maintained throughout gas making. From an oil-tank, the oil is led by a pipe to the oil syphon of the producer; and a small cock attached to the end of the pipe regulates the flow of the oil, which is permitted to run in a fine stream into the funnel of the oil-syphon. Through this it passes into the retort, and is immediately converted into a permanent gas. The gas rises into the bonnet, and passes down a stand-pipe into the hydraulic, which is filled with water to the level of the hydraulic syphon elbow, through which the gas bubbles and passes to the holder. It is asserted that the oil gas has an illuminating power four times that of coal gas; so that one-fourth the quantity of gas is consumed for any given illuminating power. Incandescent burners are adjusted for the oil gas by reducing the size of the hole in the injector. Of course, the cost depends on the price of oil and fuel. The display of incandescent gas lighting under this system is well worth an inspection.

In the machinery section of the exhibition, there is another demonstration of the use of town gas in providing electric lighting. There is to be seen a 175 brake horse power single-cylinder Crossley gas-engine, running at 180 revolutions per minute, with belt drive to a 220-volt direct-current dynamo; also a 350 brake horse power two-cylinder "National" gas-engine, running at 210 revolutions per minute, direct-coupled to a 220-volt Siemens direct-current dynamo. Both engines are driven by gas from the Company's mains.

# FACTS SPEAK.

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**Mr. W. R. HERRING, M.Inst.C.E., Chief Engineer and Manager, Edinburgh and Leith Gas Commissioners, writes:—**

"I am happy to be able to report that the results we obtain are fully equal to what is claimed."

**Messrs. THOS. GLOVER & CO., Ltd., Australian Branch, write:—**

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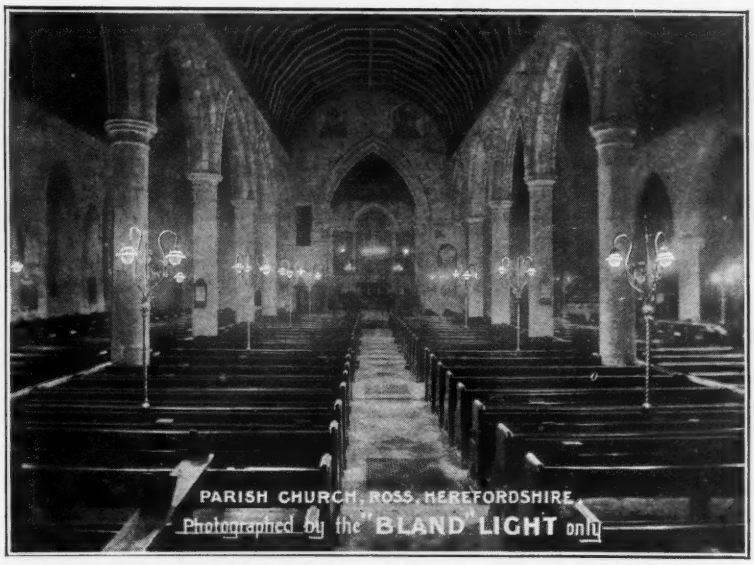


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**Mr. W. WATSON, Churchwarden, Ross Parish Church, writes:—**

"The Church formerly was in semi-darkness; it is now most brilliantly lighted. The Gas Bill is about half what it was with the old naked burners. **In Six Months' daily use I have had to replace only 3 Mantles and 1 Globe out of 55 lights."**

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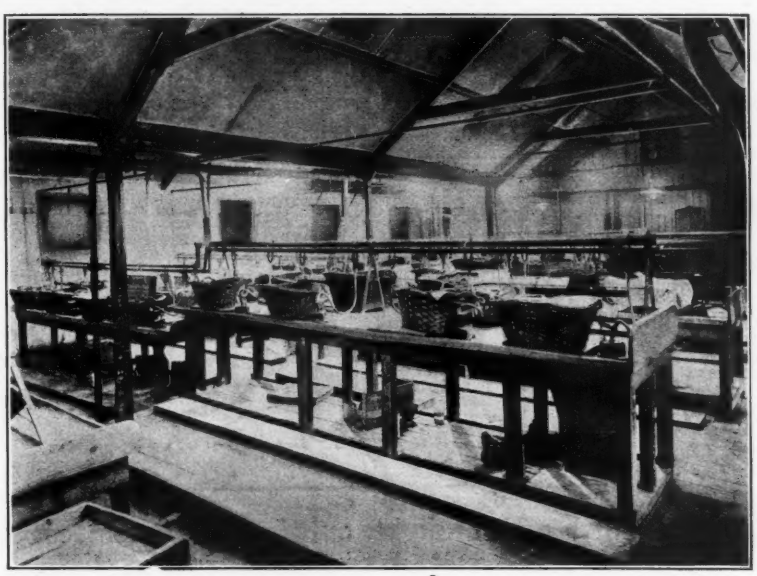

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This Machine was designed and brought out by the Patentees to supersede the Projector Charger invented, patented, and used by Mr. Wm. Fiddes in 1893, which **PROJECTOR** was **DISCARDED** by him **ON ACCOUNT OF** the packing of the Coal in the Retort, the **DUST, WASTE, FLAME, SMOKE, NOISE,** and General Discomfort to the Workmen resulting from its use.

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# PAPERS READ.

## THE SALE OF GAS.

By F. W. GOODENOUGH, of London.

A few years ago the title of this paper would undoubtedly have caused many engineers to wonder what in the world the author could have to say, and why there should be any need to talk about the selling of gas. That was in the days when the maxim that "Dividends are earned in the retort-house" passed unchallenged, save by the occasional man who realized the danger of that as of most other maxims, few of which can be adopted without qualification, as they generally attain forcefulness of expression by exaggerating one aspect of a question to the exclusion of all others. Most of the sayings that pass current as epitomes of wisdom need to be taken as subject to all sorts of limitations, conditions, and exceptions; and of none is this more true than of the particular dictum quoted above.

The writer thinks it will not be denied that, partly misled by this maxim, and partly because they unfortunately failed to realize that monopoly is not the safest and soundest foundation on which to rely solely, or even mainly, for the stability of a business, many gas managers for far too many years—long, indeed, after the enemy was at the gate—considered that practically their sole concern was to make, as skilfully and economically as possible, the quantity of gas that the public thought fit to consume. There was no regard as to whether the gas so consumed represented the total gas-consuming possibilities of the district, or whether it was used in the most economical and satisfactory manner; and no attempt was made to inform the public as to all the various ways in which they could consume gas to their own—and to the gas manufacturer's—advantage. "Take it or leave it; but if you take it, pay for it first," was the more or less plainly expressed attitude of many gas undertakings towards those who desired to avail themselves of the "privilege" of being supplied with gas.

There were, of course, always men in the gas industry who did not believe that carbonizing was the beginning and ending of their work, nor that a high and mighty attitude was either wise or becoming in a business undertaking having received special privileges at the hands of the public it was designed to serve. The hands of most of these enlightened ones, however, were, to a greater or less extent, tied by Boards and Committees, who could not take a long-sighted view of policy—and, if all that is sometimes heard be true, there are still more than a few short-sighted Boards and Committees to be found administering gas undertakings in the British Islands. On the whole, however, it is as true of our industry, as of others, that "Times change, and we with time;" and, happily, under the healthy stimulus of competition, the old cast-iron methods and uncommercial ideas are less general than formerly in the gas industry; and to-day it is widely, if not perhaps widely enough, recognized that the sale of gas is as much a trade as is the sale of provisions, clothing, or any other article of general and every-day use, and that to the selling of it must be brought the elementary principles of commerce.

*Elementary Commercial Principles.*—These principles may be said to comprise the determination to sell to as many people as possible as much as possible of an article of a carefully maintained quality calculated to give the greatest possible satisfaction, and, throughout the whole business of selling, to treat the buyers in a straightforward, considerate, and courteous manner, showing them that their custom is appreciated, and that the seller's desire is to deal fairly and honourably with them, giving them good value for their money.

The putting of these principles into practice is by no means so easy a matter as to enunciate them when the seller is—not an individual having personal knowledge of every transaction that takes place with his customers, but—a big organization having to transact its business through a large number of officials, some of whom may be tempted to assume the airs and perpetrate the crimes of "Jacks-in-office." Indeed, this, in common with the impossibility of maintaining direct personal relations between master and servant, is one of the very real drawbacks incidental to the substitution of the corporate for the individual trader. The average civility and attention with which one is treated by the counter-hands in some of our big London "stores" is considerably below that received from the small tradesman serving behind his own counter. There is, however, much truth in the old saying—"Like master, like man;" and if the head officials of a gas company are animated by the right spirit, and take care constantly to expound the principles of fair business dealings to their subordinates, the leaven will in time work wonders in the general body of the staff—to the great ultimate advantage of the undertaking, and, consequently, of its staff. The author might mention that the following notice occupies a prominent position in all the Gas Light and Coke Company's Inspectors' Offices:

> Every Officer and Workman in the Department is enjoined to remember at all times that the policy of the Company is to give prompt attention and complete satisfaction to every customer, so far as that can possibly be done without prejudice to the best interests of the Company and its other customers. It is the customers' money that pays our salaries and wages.

The following are extracts from the rules which are handed to every man employed in the Inspectors' (or "Sale of Gas") Department:

> Let every man realize—as, happily, most of the Company's men do realize—that the Company's prosperity depends upon the thorough satisfaction of their consumers, and that his prosperity depends on that of the Company. Men who do not realize and act upon these facts are not wanted. Men who do, will find the Company a good friend.
>
> * * * * * * * * *
>
> Occasionally, the Company's workmen have to deal with consumers inclined to be unreasonable, ill-tempered, or even abusive, especially in cases of disconnection of supply for non-payment. Particular care must always be taken to show every possible courtesy and forbearance towards such consumers, and to avoid loss of temper, the display of any personal feeling, or the resentment of abuse—which, it should be remembered, only reflects upon him who resorts to its use.
>
> Where it is found that a consumer has, without apparent reason, a grievance or prejudice against the Company, courtesy and discretion on the part of their servants may often discover and secure the removal of the cause of such grievance or prejudice. In any discussion with a consumer, speaking loudly or excitably should always be avoided. A quiet, confident, and respectful manner carries more weight than any amount of bluster, which only irritates and offends.

*The "Sale of Gas" Department.*—It will be observed that the writer has referred to the "Inspectors' Department" and the "Sale of Gas Department" as being interchangeable terms; and this is, in his opinion, as it should be. He does not think that the best results in the direction of increasing the sale of gas can be obtained if that side of the business is separated from the routine work of the outdoor staff and entrusted to a special canvassing staff. If an inspector is not competent to do his own canvassing, he is not qualified to occupy his position; for just the same qualifications are essential in the man who has to represent his undertaking in discussions with customers arising out of applications and complaints of all descriptions, or in the settlement of disputes as to the quantity of gas charged for, &c., as are required by the man whose business it is to persuade existing consumers to extend their use of gas, or those to become customers who are not so already.

*The Qualifications of a Gas Salesman.*—These qualifications comprise: Informed intelligence, a courteous manner, a good temper, and, above all, tact. The last-named is one of those things which, like "good taste," elude definition. Mr. John Morley once said, in regard to definitions, "I can't define an elephant; but I know one when I see one." So one may say one cannot define tact; but one knows it when one encounters it. Possibly the nearest approach to a definition is to say that tact is the gift of seeing and appreciating the points of view and the feelings of those with whom we are dealing, and doing all in our power to consider those feelings and to meet those views in a reasonable spirit. This, it will be agreed, is essential in every officer of any business concern who has dealings, whether as salesman, as collector, or as head official, with its customers; and how much more so in the officers of a company having a statutory monopoly (that dog-hanging name) or of a municipal undertaking, handicapped as to popularity by its close connection with that most unpopular of creatures—the rate-collector.

Since, then, it is necessary that the inspector should possess the qualifications essential in the canvasser, is it not obviously better economy, and certain of producing better results, to combine the two offices in one? For the inspector naturally gets the best of opportunities for canvassing work. He is generally the first representative of his

concern to make the would-be customer's acquaintance; he has to arrange for the meter and service; and, as a rule, he is requested to meet the customer on the premises to take instructions. What better opportunity for suggesting the use of gas for other purposes than those originally contemplated by the customer? The customer takes up residence, let us say, in the spring, and is induced to instal a gas-cooker, but won't talk about gas-fires. Later in the year he complains of some defect in the cooker; the inspector (already known to the customer, which is a material point gained) calls, is able possibly to explain that there is no defect—it is merely a question of the servant keeping the stove clean—gives some good advice respecting its use, and has found in the course of conversation just the opportunity he wanted to canvass for the installation of gas-fires, and for the maintenance of the consumer's incandescent burners.

Or, again, the inspector, if he is responsible for the canvassing of his district, will often, when reading the meter at the quarter, take advantage of the opportunity thus naturally afforded him to introduce additional gas appliances, to talk about the relative cost of gas and electricity, or to induce the occupier of another portion of the premises to become a consumer. In short, the inspector finds many natural opportunities, and can make many others, for seeing the customers in his district, and then canvassing them "by the way;" whereas a canvasser who is only a canvasser frequently cannot get beyond the doorstep—at any rate, in London, where canvassing pure and simple has been done to death.

*The Organization of the Sales Department.*—The best system, therefore, in the author's opinion—one which has been found to work excellently well in the case of the Company with which he is connected—is to divide up the area of supply into districts (the Gas Light and Coke Company have 75 districts, containing about 225,000 customers supplied through ordinary meters, and 260,000 supplied through prepayment meters) and to appoint an inspector for each district, to make him responsible for pushing the sale of gas therein, and to reward him annually according to the results achieved, considered in relation to the possibilities of his particular district. A monthly report as to the special work done to further the sale of gas, a quarterly return of all the statistics relating to the district, and (most important of all) a personal knowledge of each man, form an adequate basis for determining annually the reward (if any) to be granted; and a bonus each year, awarded (or withheld) on merit only, has been found an excellent stimulus to zeal and energy.

This, it must be said, is not due merely to the cash payment regarded only as cash; it is largely due to the fact that such cash payment is a token of the management's appreciation of good work done. There is more virtue—there is indeed, more cash value to the employer, to put the matter in its barest form—in the encouragement and generous appreciation of service well and faithfully performed than many people realize. One of the essential qualities of a leader of men is that he should be ungrudging (while always carefully discriminating) in the praise of subordinates. The old sage was surely right when he said that "'Tis a great sign of mediocrity to be always reserved in praise."

In addition to the district representatives, it is desirable in any large undertaking to have one or two special representatives for looking after and canvassing large firms, especially those having many branch establishments; while, of course, the head of the organization must be prepared to tackle many of the big people himself, and to deal with public lighting authorities, especially keeping his eye on the manœuvres of municipal electric light departments, of which, in the writer's district, there are no less than ten. He should endeavour to become personally acquainted with all his principal customers. The personal factor is one not to be despised in business, and an important customer will often come readily to terms or discuss matters amicably with an official he knows and trusts, when he would take up an aggressive line with one who was to him only the representative of a soulless and conscienceless corporation.

Reference has been made to "the head of the organization;" and the author considers it essential in every gas undertaking of any magnitude to have a chief official specially appointed to superintend the sale side of the business. Few engineers having charge of works of fair size can find the time, even if they have the inclination, the aptitude, and the requisite specialized knowledge, to push, in the live, persistent and untiring manner that is so necessary, the sale of the gas they have to manufacture. Where, as in most cases, the engineer is also the manager, he will naturally organize and generally direct the commercial policy of his undertaking. But it must be next to impossible for him to devote an adequate amount of time to the all-the-year-round work that is called for; and a special gas salesman has become one of the essentials of every considerable undertaking wishing to keep in the front rank.

The making full use of such opportunities as have been mentioned as coming to and being made by the inspector—or district representative, as he might more correctly be described—in the daily round of his duties, while capable of producing much good fruit in the way of increased sales of gas, by no means exhausts the means of achieving that end. In order that the system of district representatives indicated may be as fruitful as possible, several conditions are essential.

*Conditions Essential to the Success of a Forward Policy.*—In the first place, the whole business policy of the undertaking—its attitude to the public it has to serve—must be an enlightened one. The undertaking must not be merely a gas-supply business; it must be a gas-service business. That is to say, it must be willing and anxious to undertake every service for the consumer necessary to secure that the gas bought shall be used to the best advantage, and that the using of gas shall be attended by the least possible trouble to the user.

The policy of its gas sale department must be one of prompt, courteous, and skilful attention to the requirements of its customers and of conciliatory treatment of all complaints, which, when unfounded, are generally due to misapprehension, are rarely made from a desire to give trouble, and should never lead to the complaining consumer being regarded as a nuisance, but rather as a person to be converted into a satisfied, and therefore more ready, user of gas. The public as a body are very reasonable; and even an unreasonable man finds it difficult to be so if the undertaking's representative persists in regarding him as one who only desires what is just and fair.

The policy of the collecting department (which should be in the closest co-operation, if not actually amalgamated, with the sales department) must also be animated by the spirit of consideration and conciliation; so that the customers may at all times feel that they are being dealt with justly and considerately, and that the powers of a monopoly are not being unduly brought to bear upon them. To give an illustration of the sort of question between supplier and consumer that lends itself to conciliatory treatment. Many gas managers have had cases occur in their districts in which a consumer's account has been greatly increased through an escape on the internal fittings which has not been noticed for some time owing to the gas getting away into the open air. The consumer is, of course, liable for the gas wasted; but why should the gas company desire to benefit by his misfortune? The gas has only cost them the coal and the bare manufacturing charges—why should they ask for profit on what the consumer never wished to buy and has made no use of? If this view be taken, and the consumer only asked to pay for (say) half the wasted gas at the selling price, the supplier will be covered and the consumer fully satisfied with the equitable treatment he has received.

All correspondence with consumers must be carried on in a friendly and accommodating, instead of harsh and stiff-backed, spirit. The writer should always remember, moreover, that the reader can only read what is written, and that it is therefore essential that he, the writer, should take care to exactly express his meaning and attitude, and not give rise to misunderstanding or friction by failing to let the spirit which animates him appear in the written word. It is the fact that correspondence so often fails to convey to one party the actual feelings and attitude of the other that makes it desirable to deal with consumers in person rather than by correspondence. A conversation of five minutes will often do more good than twice that number of letters. The letter-writing habit is one be carefully guarded against.

It should also be constantly borne in mind, in dealing with consumers, either personally or by letter, that the consumer only understands things with the understanding and knowledge of an outsider—that he does not know the whys and wherefores of the rules laid down by a gas undertaking to govern its relations with its consumers, and usually views them with suspicion. It is therefore necessary for an officer of a gas undertaking always first of all to try and realize how any question that has arisen would appear to him if he were a consumer having no inside knowledge as to gas

administration, and so to appreciate the consumer's point of view and probable feelings. It is then far easier to explain matters to the consumer's satisfaction, to remove misapprehensions, and to create a friend who believes in the equity of your administration out of one who formerly regarded it with suspicion and dissatisfaction.

If these fundamental conditions concerning the relations of the undertaking and its customers do not exist, then the efforts of the most active district representative may easily be rendered of no avail.

In the second place, the staff of the sales department must be well instructed in all the details of their business, and the workmen employed must be skilled in their duties and have a sound practical knowledge of all the various gas appliances they are called upon to handle.

In the third place, the personal efforts of the staff must be supported and supplemented by judicious and persistent advertising, not only in the Press, but by circulars and pamphlets of suitable character.

It will perhaps be worth while to consider in greater detail some points arising out of the three groups of conditions that have been mentioned.

## I.—THE SERVICES WHICH A GAS-SUPPLY UNDERTAKING MAY ADVANTAGEOUSLY PERFORM FOR ITS CUSTOMERS.

These comprise :—

### (1) The Supplying and Fixing of Lamps, Fittings, Cookers, Fires, Engines, and every other Kind of Apparatus for the Use of Gas.

No canvassing will do much good if the customer has to be referred to a third party for the goods he is solicited to purchase or hire, or for the execution of the work entailed in the fixing of them. Every gas manager would, of course, rather have such work—with the exception, perhaps, of the fixing of gas-engines—done under the supervision of his own staff, and know that it has been carried out by men specially trained for the purpose, than run the risk of the the apparatus being discredited because of its having been improperly or unsatisfactorily fixed.

*Hire and Hire Purchase of Gas Appliances.*—The sale of fittings, stoves, and apparatus of all kinds on the extended payment system is undoubtedly of great value in developing the sale of gas; while the hiring out of cookers and fires is now so general, and has done so much to popularize the use of gas for fuel, that the barest mention of the system will suffice here, though it must be confessed that the author has been astonished to hear of so many gas undertakings still lagging behind on the question of letting fires on hire.

Gas-fires do not result in such large consumptions, taking the year through, as do gas-cookers; but the consumptions are very good and acceptable. So that, provided the rents charged are adequate to cover interest, depreciation, repairs, and exchanges, it is somewhat difficult to discover any sound argument whatever against letting gas-fires on hire, and endeavouring to get them fixed in every bedroom and "occasional" room, if not in every other room, in every house. There is one indirect advantage that has grown from the hiring-out of gas-fires that may not have occurred to some, and that is that the success of this system has led those in the electrical industry—thinking that what is good for the gas industry must be good for them—into wasting their energies and resources in pushing electricity for heating at a price which, considering the poorness of the load-factor and the frequent coincidence of the heating and the lighting loads, is considerably below cost. They are thus weakening themselves for meeting our competition in the lighting and power fields. It has been found that the poor heating result obtained from electric radiators at considerable cost, coupled with the fact that the ventilation of rooms in which they are used is seriously impaired as a consequence, have proved in many cases a good advertisement for the advantages of gas for heating.

*Fixing Gas-Fires.*—It must not be forgotten, however, that the *crux* of the gas-fire business is the fixing. If this is not done with intelligent care in regard to the arrangement of the fire-clay, and to the fixing of the flue, with careful consideration of the local conditions as to chimney draught, and in such a manner as will ensure the fire working silently and without smell, and will prevent, as far as possible, wasteful usage of gas, then the gas-fire business will not be one-half, not one-tenth, as successful as it might be. No trouble should be spared in the training of fitters and their supervisors in the satisfactory fixing of gas-fires. The author must not, however, digress into the many points arising out of the service of supplying and fixing gas apparatus, or his paper would reach dimensions far exceeding reasonable limits.

*The Show-Room.*—A well-equipped show-room is a necessary adjunct to the sale of gas branch of the business. Such a show-room should be attractive in appearance, both within and without, and should contain samples of all classes of gas apparatus fitted up ready for the demonstration of their uses and advantages. The man in charge of the show-room must be well versed in every branch of the gas supply business, be prompt, courteous, and ready in his explanations to customers, but must not have the fatal defects in a salesman of talking too much and too glibly, or endeavouring to persuade a customer that he knows what the customer wants better than he does himself. Like poets, good salesmen are born, not made; and fortunate is the manager who secures the right man for the post.

*Co-Operation with Ironmongers.*—The undertaking of all branches of work for its customers and the establishment of a good show-room need not prevent a gas undertaking from entering into a friendly and mutually advantageous agreement with the ironmongers of the town, whereby they have an inducement held out to them to utilize their opportunities for introducing gas apparatus to their customers. The Gas Light and Coke Company started such a system in their district last autumn, and the really enterprising ironmongers are beginning to benefit decidedly by its introduction; while others do very little business, and blame the Company, who, they say, are too quick in capturing business to give them a chance. Such is always the excuse of the slow mover, who fails to see that his contention is double-edged. If, of course, the ironmongers expect that enterprising gas undertakings are going to surrender bodily to their trade the business of supplying gas appliances, they are bound to be disappointed, because it has been, and is, the gas undertakings who have created, and are fostering, the gas-stove trade, and who have conducted, and are conducting, the fight against the competition of the electric light, with the result that they are reaping the reward of their enterprise, and have no intention of letting their business drift again into the backwaters where the ironmongers left it. Moreover, a large section of the public have learned to look to them for the supply of gas apparatus, and would now resent a refusal to meet their wants. But there is plenty of room still for the enterprising ironmonger to profit by, and stimulate, the demand created by, and at the cost of, the gas industry; and the gas industry may advisedly welcome, facilitate, and offer concessions in exchange for, their co-operation.

The next service which a progressive gas undertaking must be prepared to perform for its customers is—

### (2) The Maintenance of Mantles.

As to this, little need be said at this time of day, as it is now very generally recognized by gas managers that maintenance is the very essence of incandescent gas lighting. The Gas Light and Coke Company are now maintaining about 200,000 burners; and the writer would like to see the number very greatly increased. It is only quite rarely that one comes across a consumer who is able to maintain his burners in really efficient order. They are generally only attended to when they have obviously gone wrong and somebody grumbles. In large business houses, it is often the "handy man" who has to look after the burners; and everyone knows the handy man. He is competent to do all sorts of work—except the particular sort that he happens to be required to do.

*The Use of Uncollodionized Mantles.*—The only point, perhaps, which may be of interest to mention specially in regard to the maintenance of mantles, is that managers having a large number of burners to maintain might well turn their attention to the adoption of non-collodionized mantles, which are so generally used on the Continent. It has been found that there are material advantages accruing from the substitution of the non-collodionized for the ordinary type of mantle; and the writer's Company are now burning-off and using about 250,000 uncollodionized mantles a year. Possibly details in regard to the system would prove interesting to the Institution on a future occasion.

Another of the services that has been undertaken for the

consumer within the author's experience, with gratifying results, is—

(3) The Domiciliary Instruction of Consumers or their Servants in the Economical Use of the Gas-Cooker.

It having been found by experience that very many consumers who were employing gas for cooking in the district of the Gas Light and Coke Company did not understand how to use their stoves so as to get the best results for the smallest possible consumption of gas, and were consequently in many cases not using their stoves regularly and for all purposes, were not fully satisfied with gas as a cooking agent, and were therefore not such advertisers of the system as are those who thoroughly understand the use, and so enjoy all the advantages, of the gas-cooker, the Directors decided to provide lady instructors, skilled in the use of cooking-stoves, to attend at consumers' houses free of charge. At first the plan was tried of notifying every consumer for whom a cooker was fixed that a demonstrator would be sent to explain its use to the lady of the house or her servants, if desired. But only one consumer in ten responded; the remainder evidently not realizing their need of instruction.

In the cases, however, in which the demonstrator was asked to call, the need of instruction was so obvious that it was deemed advisable not to wait for consumers to ask for a demonstrator to be sent, but to notify every consumer for whom a cooker was fixed that a demonstrator would call on a stated day, unless an intimation were received that some other day would be more convenient. The result is that now in seventy cases out of every hundred full instruction is given, to the great satisfaction of the consumer, and the undoubted benefit of the Company. In the remaining 30 per cent. of cases, the consumers are quite certain they understand the use of the stove and do not wish for instruction; and this is probably the highest percentage among any body of users of gas-cookers who really do know just how to use them—if, indeed, all the 30 per cent. know as much as they think they do, which is doubtful. The consumers who are willing to listen to what the demonstrator has to say either "never can bake cakes successfully by gas" or they "don't know what the solid shelf is intended for, and it is hanging up in the scullery," or they "never can make decent toast," or "haven't realized that you can cook more than one thing at a time in the oven," or never turn the gas down after the oven is hot, and so think cooking by gas rather expensive, or don't know one or more of a dozen other things that it is essential they should know in order to get the best results out of their cookers.

In many cases in which a demonstrator has called by request, the cooker has been used for many years previously, and it has been the husband who—judging possibly by sad experience that there was a possibility of improvement—has (contrary to his wife's wishes) asked that a demonstrator should be sent. Such cases afford the demonstrator an excellent opportunity for the display of the tact which is one of the essential qualifications of those employed on this work, and rarely has one failed to convince the wife of the advantage of having expert advice on the use of the stove.

The Gaslight and Coke Company now have six expert ladies constantly employed on this work, and have already given instructions to well over 4000 consumers, many of whom have called in their friends and neighbours to hear what there was to learn. This means that between 4000 and 5000 consumers know for certain that, while the Company desire them to use plenty of gas, they do not wish them to waste it, and that the Company are genuinely anxious that the consumers shall get the maximum amount of satisfaction out of the article sold to them. In other words, there are several thousand consumers certain to recommend cooking by gas to all their friends, and certain to speak well of the Company who have enabled them to realize fully its advantages. Such recommendations the author regards as an asset of which it is not easy to compute the value, and one which is now steadily increasing in value week by week.

Moreover, the lady demonstrators have opportunities for recommending to the consumers gas-fires, hot-water circulators, and other domestic gas appliances, without too obviously canvassing. They also hear sometimes of little grievances, cherished but not previously expressed, which they are able to explain away or report for attention; while a further, and a material, advantage of their visit following upon the fixing of the cookers is that it keeps the fitters right up to the standard all the time in regard to the fixing of the stoves and the leaving of all loose parts in their proper places ready for use. The writer can certainly speak of the system as one that has more than fulfilled expectations.

In regard to instruction respecting gas-fires, in addition to the fitter showing the consumer or the servants how to light and use them, a post-card containing directions on these points is sent out after the fixing of every fire. The following is the wording of the card:—

On half the front of the post-card:

> In reference to the gas-fire which the Company have recently had the pleasure of supplying to you—and which they hope is giving every satisfaction—your attention is invited to the information given on the other side respecting the lighting of gas-fires.
>
> If at any time your gas-fires—or any other of your gas appliances—are not giving complete satisfaction, the Company will be most happy to give you all possible assistance if you will kindly communicate with the Chief Office, as above.

On the back of the card:

*How to Light a Gas-Fire.*

> First light a taper. Then, *before* applying the taper to the fire, turn on the tap for an instant—to allow the gas to displace the air in the pipe between the tap and the fire—turn the tap off again, and then, after a second or two, apply the lighted taper to the centre of the front of the fire, well above the burners and inside the fire-clay fuel, and again turn on the tap.
>
> The fire should then light with a blue flame and burn quietly. If the flame is yellow or white and burns with a "hollow" roaring noise, the gas should be turned off and relighted so as to obtain the proper flame. A fire lighted the wrong way gives little heat, while the burners and fire-clay become choked with soot.
>
> After a gas-fire has been burning full-on for about twenty minutes or half-an-hour, and has become thoroughly hot, the tap should be partially turned off, so as to avoid any unnecessary consumption of gas.
>
> No burnt matches, waste paper, cigarette ends, &c., should be thrown into a gas-fire.

There is, however, a further service to be performed for the user of stoves, and that is—

(4) The Periodical Examination and Adjustment of Gas Heating and Cooking Stoves.

This service is one which has been tried for some months in a portion of the author's district, and so satisfactory is the result, and so apparent is its necessity, that it is now being extended to other areas. No one who moves about among the consumers on his district can have failed to observe what a large proportion of gas-fires are allowed by their users (either through carelessness or ignorance—usually the latter) to get into a most unsatisfactory condition. The burners are choked with dust, broken fire-clay, or soot; the fire-clay lumps broken, disarranged, sooted-up through the fire having been incorrectly lighted, or choked with cigarette ends, matches, or rubbish; and possibly the flue detached from the elbow through the stove having been shifted by servants when cleaning the hearth. When things get quite unbearable, some consumers send for a local gas-fitter, others communicate with the gas company, while others throw out the fires and denounce the use of gas fuel thenceforth, simply because they do not realize that things could have been very different and no one has made it his business to enlighten them.

Similarly, though probably not to such a serious extent, are gas-cookers neglected and allowed to become unsatisfactory, if not unusable, with the result of dissatisfaction to the consumer and very likely a reduced consumption of gas. To meet this undoubted drawback to the increased popularity and the extended use of gas for heating and cooking, a system of periodical stove inspection and adjustment is undoubtedly called for, and the writer's Company are not the first to adopt such a system. It may be remembered that Mr. Andrew Dougall, in his Presidential Address before the Institution in 1903, mentioned the introduction of a stove inspection scheme by his Company at Tunbridge Wells.

If, then, an undertaking has organized the services of supplying on favourable terms and fixing at a reasonable charge all kinds of apparatus for the use of gas; of mantle maintenance; of instruction in the use of stoves; and of stove maintenance—it has really done much towards ensuring the

satisfaction of its customers, present and to come; but it has by no means done all necessary to achieve that end.

II.—INSTRUCTION OF STAFF AND WORKMEN.

It must next take every precaution to ensure that those services are rendered in a thoroughly skilful manner, and with this end in view must take steps to instruct the workmen who have to carry out the practical work of fixing and maintaining gas appliances in all the details of their construction and the principles governing their use, and also to enable the staff who have to supervise the men, and who have to discuss practical and commercial questions with the consumers, to acquire all the knowledge that will be helpful to them in the performance of their duties. With a view to achieving these ends, the Gaslight and Coke Company are carrying through a series of practical demonstrations to all their fitters and their assistants of the correct and the incorrect way of fixing and adjusting gas apparatus. The men themselves take part in the demonstration work, which is accompanied and followed by clear and simple explanations of the causes which produce the desired and the undesired effects—entailing, necessarily, descriptions and explanations of the construction of each appliance. It is found that the men greatly appreciate these courses of instruction, which help them to take a greater interest in their work and are of no little assistance to those who are anxious to qualify themselves for advancement in the service.

These latter men have also open to them—as they are open to all the staff of the Department—courses of lectures (followed by examinations) dealing in much greater detail and on more scientific lines with all the matters with which it is essential that the district representatives of a gas undertaking should be familiar. These include, not merely full information respecting the varied uses of gas, but also accurate knowledge concerning all its competitors—electricity for lighting and for power, producer gas, steam, oil, and acetylene—and therefore constitute a wide field of study and instruction. As a supplement to these lectures, the staff meet from time to time to hear and discuss papers on subjects connected with their work, contributed generally by one of their number. The officers in charge of the ten local offices from which groups of districts are worked also periodically meet for the discussion of matters of common interest; so do the head show-room men; and so do the foremen.

Moreover, representatives of the inspectors and of the collectors meet from time to time to talk over questions arising out of their experiences on the district, and to consider any suggestions that may be made for furthering the Company's interests—and it may be added that such suggestions are asked for and welcomed from every servant of the Company. Everything possible, in fact, is done in order to secure the interchange of ideas and experience throughout the staff, and to increase the knowledge and the efficiency of every member of it. This is more than ever necessary in these days, when the public expect to receive from gas representatives—and it is desirable that gas undertakings should be willing and anxious to give—reliable information and unimpeachable advice on all matters connected with the use of gas; and when at any time those representatives may be called upon to discuss with shrewd business men the relative merits of gas and its competitors.

Given the organization of the services necessary to ensure the satisfaction of the consumer, and a well-trained staff to carry out those services, there remains to be developed one other line of action necessary to secure the fullest results from the personal efforts of district representatives to increase the use of gas by existing consumers and to secure additional customers. And that is, a carefully organized and properly directed system of—

III.—ADVERTISING (INCLUDING CIRCULARIZING AND CANVASSING).

The author is a firm believer in the advantages of advertising. A business that keeps itself constantly in the minds of the public by attractive, interesting and persuasive, but not vulgar or flamboyant, advertising—advertising which is a truthful, if forcible, statement of the advantages that can actually be realized, not the untruthful puffing of something that has no real value—will always be regarded with more favour by the public than a somnolent, silent concern that hides its light beneath a bushel. The public undoubtedly have a leaning towards dealing with a firm having a reputation for being business-like and up to date. Moreover, the entry of a gas company into the arena as an advertiser does much to remove from the minds of the public the idea that it is a business relying upon a monopoly for its success. It takes up its stand as a trading concern seeking the patronage of the public on the merits of what it can do for, and supply to, them, and is consequently viewed in a very different light by its customers from that in which they would regard a statutory company which contented itself with leaning upon its statutory rights.

In regard to this question of advertising, the gas managers of this country have much to learn from their American brethren, who have (with much benefit to their undertakings) developed that line of action on a scale and with a thoroughness that have been far in advance of what has been attempted in this country. The writer has several kind friends on the other side who have furnished him, and continue to furnish him, with full particulars of what is being done over there on the publicity side of the gas business; and the enterprise of American Companies in the way of pushing the sale of gas would be quite startling to some gas administrators in this country if they could know as much of it as the writer has had the privilege of learning.

Press advertisements should go straight to the point in as brief but effective a manner as possible. One strong line embodying a point strictly relative to the substance of the advertisement, yet calculated to arrest the attention of anyone glancing at it, is very helpful to the effectiveness of the matter, which should be worded tersely and convincingly, with a view to leaving some definite thought in the mind of the reader. Suitable pictorial matter is also very effective, but it must be really well done. Every statement made in an advertisement should be absolutely true and free from exaggeration, which would only bring discredit eventually upon the undertaking which issued it. As one of the journals devoted to the subject recently said: "Truth in advertising—apart altogether from the ethics of the question—is vital to its success, and the most successful advertisers are those whose announcements stick most closely to true and accurate description." The matter of press advertisements should be varied frequently, and the subject be changed according to the season of the year—cookers and hot-water circulators in the spring and summer, lighting and gas-fires in the autumn and winter.

Where, however, should a gas undertaking advertise? First, in the daily and weekly papers whose circulation coincides, as nearly as may be, with the area of supply. This does good in more ways than one; it not only keeps the Company's name to the fore and leads to an increased use of gas, but it also ensures a friendly attitude on the part of the Press. By this it is not meant that the Press is to be bought by advertisements, or that it shows undue favour to advertisers, but that amicable relations with the Press help to prevent uninformed and misleading statements being made in the papers, as, in the event of reports affecting an advertiser reaching the Press, inquiry would be made of him, and his side of the question would be considered before the publication of what, but for correction, might be altogether misleading.

Moreover, the supply and the multitudinous usages of gas involve domestic, industrial, and public questions that are of interest to practically every reader of the newspapers. There is therefore often information that can be given by a gas manager which would constitute interesting copy for the Press. But it is only human nature to expect that an editor will take a more liberal view of the space that can be devoted to such information, however interesting and useful it may be, if the person who supplies it is a purchaser of space in the advertisement columns than if he is not. The business world is a business world, and newspaper proprietors, faithful public servants as the vast majority of them are, are, after all, business men.

In the case of the author's Company, it is not possible to confine their advertising to papers the circulation of which is limited to the area of supply, as the many valuable periodicals which appeal specially to the housewife and which are published and have a considerable circulation in the Metropolis, also have a large circulation up and down the country. The Company's advertising in these publications, therefore, as is proved by correspondence received from consumers outside the district, benefits the industry generally to some extent. Of course, such advertising would not be done if it could be avoided, because it is not any company's business to advertise for the benefit of others; but if those others felt inclined to bear a share of the expense, the

volume of advertising could be increased, to the advantage of the industry as a whole. The writer will only add that he is not authorized to give receipts on behalf of the Gas Light and Coke Company; but remittances addressed to their Cashier will receive prompt attention. Seriously, the question of a joint fund for advertising in publications of general circulation is one to which he thinks consideration might well be devoted by the Institution.

In the second place, poster advertising may be resorted to for special occasions or at special seasons. The principal point to be observed here is that a poster to be any good at all must be a large one; and then it must be attractive and very pointed. One ought never to have to stop to read a poster—it must be a case of "he who runs may read."

Another field altogether for advertising is that of the direct appeal to the customer. Very few consumers use as much gas as they would if they realized all the many ways in which it can be consumed to advantage in the home and in the place of business. The "Sale of Gas" department should therefore be frequently talking to their customers by circular, catalogue, pamphlet, or booklet. Consider, indeed, how much more easy and less expensive this is for a gas undertaking than for a firm which is never quite sure who are or who might be its customers. A draper may send out ten circulars to people he hopes are, or will be, his customers, yet only one of the ten people may ever come to him for drapery. But every single person within a gas company's district must come to it for gas, if he goes to anyone; so that circularizing is necessarily more fruitful of result per pound expended when addressed to the customers of a gas company than when addressed to those of almost any other concern.

The remarks as to truthfulness, aptness, and convincing wording, which have been made in regard to Press advertisements, apply, of course, to circulars and pamphlets; the latter, however, lending themselves better than any single advertisement to a complete and well-argued statement of a case. The one therefore serves as a complement to the other; and it is often well to ask the reader of an advertisement to write for a pamphlet dealing more fully with the subject advertised. Appropriate illustrations, if well done, add materially to the value of a pamphlet. Then it should be pointed out that a gas company has many natural opportunities for sending circulars, &c., to its customers at very small cost. An advertisement can be issued with, as well as on, every account, with every receipt, with every acknowledgment of a communication, and in every letter. Then every quarter, if necessary, circulars, &c., can be delivered by the meter readers. Circulars are most effective when they take the form of letters printed in imitation type-writing and addressed personally to each consumer by the type-writers. No circular letter designed to bring in orders should ever begin "Dear Sir or Madam," as so many do. Such an opening inevitably consigns the letter to the waste-paper basket.

It has been found advantageous to sort out, specially circularize, and canvass all consumers who use considerably less gas than their neighbours, as well as those residents in the district who use no gas and are desirable as consumers. It is also necessary to watch very carefully all capped services, and capped stove supplies. To the latter may be attached post-card forms ready for the consumer to send to the district office if a stove is wanted. New and empty premises also require to be watched closely. In regard to the former, every effort should be made to secure the adequate carcassing of all premises during erection. In regard to the latter, the district representatives should always keep an eye on furniture-removing vans, as they thereby can often get into touch with incoming tenants at the earliest possible date, and secure their orders in good time. It need perhaps hardly be added that the asking for deposits should be avoided, except in the case of really "doubtful" customers. A very low bad-debt percentage can be very dearly bought, and this endeavour to avoid altogether the risks that necessarily attend a commercial enterprise has done much harm to many a gas undertaking in the past. Reasonable care should be taken to avoid being defrauded by unscrupulous and dishonest persons; but to take no risk at all in business is to make poor profits, and to achieve an unenviable reputation in the commercial world.

The author has he thinks now dealt, more or less completely, with the main points to which attention has to be given if the sale of gas is to be forwarded effectively by a staff organized on the lines he has suggested. Much more might be said on many of these points; but he feels that his paper has already far exceeded reasonable limits, and can only plead the importance of the subject, and his belief in the great possibilities it holds for the gas industry as a whole, as his excuse for having presumed to levy such a heavy tax upon the attention of his hearers.

## GAS CONSUMPTION DEVELOPMENT OF SMALL UNDERTAKINGS.

By JOHN G. TOOMS, of Waterford.

It is usually considered that the main factor governing increased consumption of gas in districts where populations are stationary is, as with most other articles, the price at which it is sold; but the author is convinced that such an assumption is wrong. He contends that the increased use and consumption of gas depends in a far greater degree on the outdoor service rendered to customers by the gas administration, than it does on the price per 1000 cubic feet at which the gas is sold.

There are now some gas undertakings the outdoor departments of which are conducted on modern and up-to-date commercial lines. Facilities are offered to existing and prospective customers to acquire gas-fittings and any other gas-using apparatus on hire, hire-purchase, and for cash, at low yet remunerative rates; the proper fixing and maintenance of all appliances is carried out; and their systematic inspection is attended to so as to ensure that gas is being consumed to the best advantage. Such methods constitute real live forces, having an enormous effect upon the development of consumption where they are introduced, and the welfare of the gas industry in general. Any gas undertaking conducted in the above manner, with the addition of the usual adjuncts of a well-managed commercial enterprise —such as advertising, &c., &c.—will make more substantial progress, and will serve its customers better than will any otherwise well-managed similar undertaking selling gas from 20 to 30 per cent. cheaper. In the latter case possibly, beyond fixing slot cookers and meters, little is done for the customer, who is left to his own devices, or oftentimes to the tender mercies of the plumber and bell-hanger.

To give an illustration—one gas undertaking supplies lighting gas at 1s. 6d. per 1000 cubic feet. Consumed through flat-flame burners, at the rate of 6 cubic feet per hour, a light of 15-candle power may be obtained for a period of 110 hours at a cost of 1s. Another progressive undertaking supplies gas at (say) the extreme price of 5s. per 1000 cubic feet, but advises consumers to use the gas by efficient and economical means through Kern burners. Thus with a No. 0 Kern burner this undertaking gives a light of 20-candle power for 200 hours for 1s., or nearly twice the value given by the cheap-gas undertaking, which, of course, the writer is assuming makes no real attempt to induce its consumers to use the gas economically. He has formed these conclusions from experience of the development of gas consumption which has taken place in connection with the undertaking with which he is directly connected, and with others in which he is interested, where increases of from 55 per cent. to 250 per cent. have been effected within the last ten years, though (as will be seen by Table I.) the price charged for gas in every case has been relatively high—and, let it be emphasized, the populations have either dwindled or remained at a standstill.

TABLE I.

*Showing Increased Consumption and Average Price Received for Gas.*

| Undertakings. | Consumption Year ending June, 1896. | Price Received per 1000. | Consumption Year ending June, 1901. | Price Received per 1000. | Consumption Year ending June, 1906. | Price Received per 1000. |
|---|---|---|---|---|---|---|
| | Cubic Feet. | s. d. | Cubic Feet. | s. d. | Cubic Feet. | s. d. |
| Waterford . . | 48,049,100 | 3 11¾ | 61,896,200 | 4 3 | 74,946,600 | 3 9 |
| Kilkenny . . | 11,136,400 | 5 4¾ | 15,274,900 | 5 5½ | 20,479,500 | 5 0 |
| Tipperary . . | 7,944,800 | 6 0 | 10,580,800 | 5 8 | 14,145,900 | 4 11¾ |
| Fermoy . . . | 4,422,900 | 5 8 | 5,901,600 | 6 1 | 8,045,500 | 5 2½ |
| Carrick-on-Suir | 1,708,700 | 6 10 | 3,340,500 | 5 11½ | 4,468,500 | 5 4¾ |
| Bagnalstown . | 1,137,900 | 7 1 | 1,728,900 | 6 8 | 2,132,300 | 5 10 |
| Mallow . . . | 1,557,400 | 6 10½ | 2,927,000 | 6 0 | 5,449,200 | 5 8 |

*Note.*—In all the above cases differential prices were in vogue at some time during the period covered.

The towns which these undertakings supply are situated in the South of Ireland; and if they are as prosperous as in 1897, they certainly are not more so. If such development of consumption is to be obtained under these adverse conditions, surely very much greater expansion and development can, and should, be obtained in more prosperous communities, where the industrial portion of the population are earning sufficient wages to enable them to use gas, and where gas is cheaper.

It is essential for the progress of small works that all the gas-fitting required in their respective districts should be carried out by the undertakings. Should this be not the practice, however, there is no reason why, if the manager be competent, and has the necessary energy, he should not capture such business in a very short time. The writer has lately been much surprised to note a tendency on the part of some large gas undertakings to depute a portion of this work and its responsibilities to third parties—ironmongers, &c., and can only presume there must be special reasons for this, to his mind, distinctly retrograde movement, which even in principle seems to have very little to recommend it. He believes that it will result in absolute failure compared with other undertakings carrying out the business themselves on modern lines. In Waterford, 99 per cent. of the total gas-fitting work is executed by the Gas Company; and in connection with the other works referred to in Table I. a similar state of affairs exists. The consequence is that the undertakings are, through their outdoor staff, kept in intimate touch with the customers and their requirements. In this connection a scheme has been adopted whereby apprentices of a superior order are obtained from the trade classes of the technical day schools, which it is expected will in time bear good results.

Arising out of the fittings business, there is the question as to whether a profit should be made on this department, and, if so, what percentage. In the writer's opinion, it matters not whether the profit be *nil* or only sufficient to cover incidental expenses—say 10 or 20 per cent.—so long as the business be got and the prices do not preclude people from becoming customers. Oftentimes it would be good policy to incur a loss on such work, in order to obtain an increase in gas consumption.

There has been during the past few years a fairly general awakening of gas authorities as to the possibility of development of sales of gas for all purposes; but it is surprising to find so few undertakings making any real attempt to take advantage of the opportunities known to exist close to their very doors. No undertaking should wait for business to come in, but all should go out and seek it. It has been said that electricity competition has been a blessing in disguise to the gas industry. In so far as it has been the direct means of forcing gas undertakings to set their house in order, and to conduct their outdoor service on modern and commercial lines, the author is prepared to accept the statement. In Waterford, the principle for many years has been to anticipate the advent of electricity, or any other competitor, by carrying on the gas business as if the most deadly competitor were being contended with. Thus if ever such competition has to be met, the undertaking will occupy a very strong position, and it will not be patent to the public that the company only bestirred itself after the arrival of competitors—which will be an asset few undertakings have any claim to. The best possible service, with adequate pressure of gas at all times, along with immediate attention to complaints, has gained many friends.

All gas undertakings should advertise in some form or other. The sale of gas will be benefited by judicious advertisement quite as much as any other commodity will be. Show-rooms should be opened by all except very small undertakings; but it is not sufficient to have a shop in a second-rate street, opened for two or three days per week, or two or three hours per day, with one or two dusty stoves and other equally attractive articles to be seen. The writer has known of show-rooms conducted in this fashion. The show-rooms must be situated in one of the principal streets, and well fitted up with every variety of gas appliance for all purposes; and the window show should be changed weekly. The rooms should be kept open from (say) 9 o'clock in the morning till 7 in the evening, and later on Saturdays, and be in charge of smart capable assistants, conversant with all apparatus, competent to advise customers and to intelligently receive particulars of complaints. Unless the show-room business as an advertising medium be done thoroughly, it had better be left severely alone.

Advertisements should be run in local papers, and should be frequently changed, according to the season of the year. At Waterford, much benefit has been derived from emphasizing such facts as "One pennyworth of gas is guaranteed to give a light of 20-candle power for 20 hours with No. 0 Kern burners," &c. In regard to circulars, they provide a means of advertisement that can be used by very small undertakings as well as by larger ones. Such circulars should set out in a concise manner plain facts which can be guaranteed to be substantiated in practice. The writer has found the policy of never claiming a higher duty for gas than that warranted by his own experience, a very paying one. Some time ago he received an inquiry with reference to a 50 H.P. engine to be worked 50 hours per week. The price of gas in Waterford being 3s. 4d. per 1000 cubic feet, he advised a suction plant as being the cheapest system under the circumstances, and has found that not attempting to mislead in any way has been of considerable advantage to the Gas Company in other directions.

Local copies of testimonials as to costs and savings effected should be well circulated. It is surprising how difficult it is to combat the general impression that there is no saving by the adoption of incandescent burners in lieu of flat-flames, and the feeling that gas undertakings would never advocate the use of an article that reduced the consumption of their commodity. In connection with a public institution in Waterford, by fixing No. 0 and No. 2 Kerns in lieu of flat flames, the half year's account for lighting was reduced from £117 to £43, the latter figure including maintenance; and the institution was much better lighted, a testimonial to that effect being given.

Copies of "Gas Progress" and similar publications have been freely circulated at Waterford with good results; the general aim of the advertising methods adopted being to keep the advantage of gas constantly before the public. To interest the Twentieth Century public, such methods must be interesting; and in devising and introducing them, it is necessary that the undertaking should put itself in the position of its would-be customers. Gas officials do not always appreciate the fact that, though they themselves are aware of the vast superiority of gas over its rivals for most purposes, their duty is to convince the 1907 public that such is the case. And it must not be forgotten that oftentimes the public are very sceptical regarding any statements emanating from gas offices. After some years' experience of advertising on a fairly liberal scale for a small gas company, the writer is certain that every penny so used has been well spent, and feels there are sources of development yet untouched which by its aid will be ultimately reached.

Public lighting by incandescent burners may be, and has been, one of the best advertisements gas ever had. Yet, according to the gas directories, there are still a number of undertakings big and little which have only a small percentage of their public lamps fitted with such burners, and some which have none at all. In nearly all cases it may be said that the cause lies with the gas authorities.

In very few instances would incandescent lighting (allowing the initial cost of change from the flat flame to be spread over five years) represent more to the supply authorities than the present cost of the change. Six years ago in Waterford, 40 public lamps were fitted with incandescent burners at the Company's own expense, and kept in order for the last twelve months of an expiring contract. As a result, a renewal of the contract for all incandescent lighting for five years was obtained at the same price as had been previously paid for flat flames. One-fourth of the quantity of gas used formerly is saved—representing a sum sufficient to cover the charges for redemption of initial cost and maintenance. The illuminating power is increased five-fold, and a five years' standing advertisement second to none secured.

The most profitable development of business for any undertaking to cultivate is additional consumption by present consumers. If consumers be classified, and an analysis made of the appliances in use by them, the enormous scope there is in the direction of placing industrial and domestic appliances will be realized. In Waterford, the success that has been achieved in this way will be apparent on reference to Table II., which shows for the years ending June, 1896, 1901, and 1906 respectively the total number of consumers classified, as well as average consumptions per consumer.

A most important question in the satisfactory performance of all gas appliances is that of pressure. That it is now a vital item to be considered in connection with the use of gas for all purposes, cannot be too strongly emphasized. The

TABLE II.—*Increased Consumption per Consumer in Waterford over Ten Years.*

| Years ending June. | Number of Consumers. | | | | Gas Used. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Ordinary Meters. | | Ordinary Slot Meters. | | Installations. | | All Meters. | |
| | Ordinary. | Ordinary Slot. | Free Stoves and Fittings Installation. | Totals. | Total. | Average per Consumer. | Total. | Average per Consumer. | Total. | Average per Consumer. | Total Gas Used. | Average of Total Consumers |
| | | | | | Cubic Feet. | Cubic Feet. | Cubic Feet. | Cubic Feet. | Cubic Feet. | Cubic Feet. | Cubic Feet. | Cubic Feet. |
| 1896 | 955 | 98 | Nil | 1053 | 47,360,100 | 49,500 | 689,000 | 7,000 | Nil | Nil | 48,049,100 | 45,700 |
| 1901 | 823 | 288 | Nil | 1111 | 59,172,600 | 71,900 | 2,723,600 | 9,400 | Nil | Nil | 61,896,200 | 55,700 |
| 1906 | 710 | 573 | 400 | 1683 | 62,413,700 | 87,800 | 8,760,700 | 15,300 | 3,772,200 | 9,400 | 74,946,600 | 44,500 |

NOTE.—There are two classes of prepayment consumers included above. (1) The ordinary slot—being consumers owning their own fittings, and paying hire for or owning cookers, who are charged through slot meters the ordinary price of gas. (2) The free stove and fittings installation; being consumers supplied with cookers, fittings, and incandescent burners, with free maintenance of burners, and charged through the slot meter an extra 1s. 3d. per 1000 cubic feet of gas.

author is of opinion that it will soon be a recognized practice to maintain a uniform pressure on the supply mains throughout the 24 hours; for it is unreasonable to expect satisfactory working from any appliance if the pressure varies within wide limits during the time of its use. A constant pressure would enable the fitters, and inspectors to properly adjust all apparatus during the ordinary working hours; whereas it is now frequently necessary to make these adjustments for lighting purposes after the night pressure has been put on. It is found impossible to properly adjust all appliances for the varying pressures at present in vogue. It may be advanced that a consumer's governor overcomes such difficulties; but the writer is not at all in favour of single governors fixed on the outlets of meters to regulate pressure of gas required for totally different purposes. To separately govern each appliance will be found too expensive in practice for general adoption. There appears to be no objection to a practically constant uniform pressure, except that a very small increase in the unaccounted-for gas might be expected, which in its significance would surely be regarded as negligible compared with the many advantages to be obtained, more especially by the consumers.

Over 90 per cent. of the gas used for lighting in Waterford is by means of incandescent burners of an economical type. According to a census recently taken of the whole of the consumers, there were connected 16,327 gas-burners, as follows:—

| | | | |
|---|---|---|---|
| Ordinary meters . . . | 7,085 incandescent burners | 5576 flat flames. |
| Ordinary slots . . . | 1,436 " " | 488 " |
| Installation slots . . . | 1,160 " " | *nil.* |
| Public lighting . . . | 582 " " | *nil.* |
| | 10,263 incandescent burners | 6064 flat flames. |

When account is taken of the proportion of lights available but seldom used in stores, offices, houses, and large institutions, &c., for which flat-flames are mostly retained, it will be agreed that only a small proportion of gas for lighting is now consumed by means of flat-flame burners.

In preparing this paper, the author has endeavoured to show that painstaking service to consumers merits not only attention, but more actual practice than it has received in the past, or is receiving at present in the case of most undertakings. At the commencement he advanced the proposition that the main factor governing increased use of gas was the outdoor service and attention rendered to consumers by the gas authorities, and not the price charged per 1000 cubic feet. The increased consumptions recorded in the tables, which, it must be remembered, were all obtained under the most adverse conditions of high price per 1000 cubic feet, and declining populations and industries, are in his opinion sufficient justification for the conclusions he has put forward.

He is, of course, fully aware that the ground that comes within the scope of the title of the paper has not been nearly covered—including as it does the most important branch of business to be dealt with in the future. Every year new competitors arise and old ones succeed in getting into closer range. Some members may consider they have had a strenuous time in the past; but there is not the slightest doubt that if the gas industry is to retain its supremacy it will be necessary for all to strain every nerve in the endeavour to improve methods, to keep each department up to the high-water mark of efficiency—never underrating any competitor.

## Discussion.

Mr. F. T. COTTON (Dublin) congratulated the readers on the excellence of the papers they had put before the meeting. It was curious, he said, to note that two papers—one coming from London and the other one from Waterford—should be so similar in all respects as to their recommendations of how the consumer should be treated. Mr. Goodenough told them how to compete with the electric light; Mr. Tooms told them how to shut the door in its face. He hoped the latter gentleman would always be in the happy position of being able to keep the electric light outside the door. Mr. Goodenough was an expert on competing with the electric light. He was in the unique position of representing the Gaslight and Coke Company, who, he thought, had had more competition from that source than any other Company in the world. In the West-end of London, where there was a wealthy community with whom money was no object, they did not care what it cost, if electric light was the fashion; they would have it. But Mr. Goodenough had been able to give them gas which they liked much better. The only remark in his paper to which exception could be taken was in the last paragraph, where he said he had imposed a heavy tax on the attention of his hearers. On the contrary, it had been a great pleasure to every one who had heard him. With reference to the question of advertising, the President had said that this was a fine art. Every gas manager had experienced the same difficulty—that, no matter what he spent upon advertising, he could not tell what return he was getting for it. Mr. Goodenough had suggested that there should be one central place for advertising, and that all should subscribe to it. No doubt if this were carried out, great benefit would be derived from it, as then they could advertise in papers which were sold all over the country. He would suggest that Mr. Goodenough should be deputed to fill the office of looking after advertising generally, when it would be in proper hands. He (Mr. Cotton) had with him a picture from a weekly paper, for which he was quite sure Mr. Goodenough was not responsible. It represented a lady disappearing through a kitchen door, accompanied by pots, pans, kettles, and all sorts of cooking utensils; and it bore the legend: "Leave her to do things by herself, and the gas-stove will save much anxiety and expense." If a central advertising office were ever established, such caricatures as this would certainly not be published.

Mr. R. BRUCE ANDERSON (London) thought that the best thing for a gas company to do was to get good men and trust them, and then try to impress on the customers that the company trusted them. If gas companies looked upon their employees as men to be managed, and did not place confidence in them themselves, they could not expect others to do so. Mr. Goodenough had been at a loss for a definition of the word "tact." He (Mr. Anderson) thought it was the capability of seeing both sides of the shield—that was to say, the consumer's side as well as the gas manager's. He did not agree with the condemnation of peripatetic canvassers. In his opinion, a strange canvasser coming into a town did good. The consumers got to know the regular employee of the Company, and felt that they could see him at any time; and any time was no time. He differed from Mr. Goodenough on the question of the hire of gas-fires. It was not a question of the price of the gas. Where he lived in London, the charge was 2s. per 1000 cubic feet; but he could not afford gas-fires except in bedrooms, where gas was seldom used. In his opinion, hiring out gas-fires

had done the companies more harm than good. Mr. Goodenough, in his treatment of the question of the introduction of the ironmonger into the gas companies' business, had rather "damned" the idea with "faint praise." The two interests must conflict. It was to the ironmonger's interest to sell the most expensive article at the greatest profit. The gas company, on the other hand, had an interest in selling the very best article at the lowest price. On the question of maintenance, he was surprised at the small number of burners Mr. Goodenough had to maintain. His feeling was that maintenance ought to be done at bare cost, and not with any idea of making a profit. The employment of lady canvassers should be very carefully managed. He had experience ten years ago of employing ladies, who did a certain amount of harm by calling at houses promiscuously. The lady canvasser should always call by appointment. House-to-house visitation was not welcomed by ladies, as the kitchen might not always be in a fit state to receive a visitor. Men were not so much objected to on this score. He would suggest that the Gaslight and Coke Company should allow visitors from small provincial works at the practical demonstrations held by the Company. There were a number of provincial companies who would like to send men to these demonstrations. It would not do the Gaslight and Coke Company any harm, and would do an enormous amount of good to the employees. With regard to the question of pictorial advertising, he suggested that this should be carried out on co-operative lines. Could not the Gaslight and Coke Company so word their pamphlets, &c., that they could be used by any other gas company? Referring to Mr. Tooms's paper, he would point out that in the towns mentioned in Table II. there was no increase in population or building going on. He quite agreed as to the efficacy of a good show-room. A small gas company who could not bear the expense had far better do the thing well for a short time than try to do it in a second-rate manner continuously.

Mr. J. W. Helps (Croydon) said he was one of the first to take up the system of ironmongers' agreements. He did not agree entirely with Mr. Tooms, because, in his opinion, some sort of an agreement with the ironmonger was really an advantage. There were three ways in which ironmongers could look upon the business. They could be absolutely hostile, or apathetic, or they could be induced to take a certain interest in the work, and therefore be of considerable benefit to the company. But it was a great mistake for the company to make to treat the ironmonger too much in the light of an agent. Mr. Goodenough had pointed out how important it was that the various inspectors and fitters should be educated in the methods they ought to adopt; but this would be impossible for the ironmonger, who could not have his men so much at his command as a company could. It was only fair that they should enable the ironmongers to work with them, and that they should get some profit thereby. It was not fair that the company should sell fittings and gas apparatus at cost price—sometimes even at a loss. There were occasions when they might do it; but, as a rule, it was only fair that they should have some sort of arrangement whereby they should not undersell the ironmonger when dealing with fittings. If some agreement were drawn up by which they could satisfy the ironmonger that they did not want to deal unfairly with him, and that he would receive some commission, it would be of immense benefit to the gas companies who undertook this work. He did not entirely agree with Mr. Goodenough that the whole of the canvassing should be entrusted to the inspectors of the company. He had raised the objection that if a monetary inducement were held out to the inspector to canvass fresh customers, he would probably neglect more important work. But Mr. Goodenough claimed that he always had a check on the work done, and was able to prevent neglect. While agreeing that some of the canvassing of fresh consumers might be left to the inspector, he thought there was scope in this direction for the employment of the special canvasser to whom Mr. Goodenough objected. He heartily agreed in recommending the employment of lady canvassers, notwithstanding the fact that he had failed in this direction. In his case, he adopted the plan of letting the ladies call promiscuously—not by appointment; and he was sure their visits were at times unwelcome. According to Mr. Goodenough's system, the lady (by appointment) followed the stove; and there being thus some reason for it, her visits were welcome ninety-nine cases out of a hundred.

Mr. R. M. Searle (Rochester, N.Y.) said he occupied the unique position of being dual manager of an electric light and a gas undertaking. His first experience of the gas business was in the retort-house, but it was not many years before he realized that ten times the profit could be made for his Company in the Commercial Department as against the Retort Department. At Rochester, they had 40,000 customers, for the supply of whom they had one of the largest electric lighting plants in the world, embracing nine stations varying from 110 volts to 60,000 volts. When he took over the management, he guaranteed to the proprietors 100 per cent. increase in the Gas Department in five years. So far he had shown an increase of 15 per cent. over last year. To start with, it was realized that advertising was a fine art; and therefore a man was employed solely to write advertisements. In America, every woman referred to the fact that she cooked by gas by saying, "I have a gas-range;" she never said that she did cooking by gas. Therefore in their advertisements they had adopted the slogan: "Get a gas-range." They went so far as to put it on their waggons instead of the name of the Company. His Company employed people to read the papers all over the country, and were instructed to bring to him copies of everything pertinent to his business, from which he got his education. A commercial lecture was delivered to the men employed in the Commercial Department every morning, followed by a discussion of the complaints received the day before, and the letters written in reply to them. It did not take more than ten days for a canvasser to become a full-fledged agitator. But he did not go about exaggerating; he simply stated the truth. Of course, there was a great deal of criticism of their Company, because people did not realize what they had done for them. The Commercial Department was formed as much with the idea of increasing the consumption of the old customers as getting new ones. In Rochester, they figured out that they could double the consumption of an old customer. A "History Card" of every house was kept, on which was recorded everything there was in the house; and it was the canvasser's duty to get everything else into the house. If he did not do so, the card for this particular house was picked out, kept in a live cabinet, and treated every morning until that one particular property was, as it was called, "cleaned up." When a consumer made a complaint, he (Mr. Searle) thought it was the Company's duty to carry out the work for him; and he did not give them any credit for having done anything. Therefore he insisted that all the work they did in this way should be billed to the customer at ordinary plumbing rates, and then the bill should be stamped with a rubber stamp, and the words "No charge" added. Then again the canvasser was instructed to get from each customer a letter saying that his complaints had been attended to to his entire satisfaction. Since the 1st of January, he had succeeded in placing 2000 gas-ranges and 20,000 sets of fixtures in houses that were never touched before. They were now pushing an electric lighting combination fixture in gas consumers' houses. It was found that while the consumption of gas was slightly reduced, the Company's income from this particular property was increased 65 per cent.; because both gas and electricity were used after a few months, providing, of course, that the fixture was a combination one. They were putting in an automatic water heater, and the gas consumption would be well expended in giving a supply of hot water. They started on the supply of these heaters with fear and trepidation. They began with five, and the week he left for Ireland they were sending out a carload of 80. These appliances sold at £20; and it was calculated that, on the average, they would easily bring in £1 10s. a month from the well-to-do people. As there were many of the wealthier class in Rochester, they did not expect to lose anything by pushing the combination light. With a large number of canvassers, there was always one who was more successful than the others. In their case, it was found that one man was turning out ten times the business that any other man was doing; and he was asked to explain how he did it. His method was this: He got three or four orders for gas-ranges in one street. He then hired the kitchen of one house where a new range had been set; and while his wife gave demonstrations in cookery, he took orders. He actually brought in ten times the business of any other man; and last year he netted about £500 for himself. On the question of leaving the business of the supply of gas-ranges to the ironmonger, he spent ten years in trying to educate the ironmonger up to co-operating with the Company; and the only way he knew of was to pay him a liberal commission on every order he brought in. Mr. Goodenough and Mr. Tooms had more than enthused him;

and he did not see that their policy could be improved upon. He concluded by assuring his hearers that there was more money to be made to-day for a given amount of brains in the Commercial Department than there was in the Retort Department of a gas undertaking.

Mr. GEORGE HELPS (Nuneaton) thanked the authors for the information their papers supplied, which would, he said, be capable of application by all, more or less. The hire-purchase system was, in his opinion, one of which they could not emphasize the usefulness too much. He still wondered why there were so many companies charging for slot meters and so on a fixed sum in perpetuity, instead of setting aside this sum against the cost of the installation, and in time allowing the customer to benefit by it. He wished to ask Mr. Goodenough if he had introduced any special price for gas-fires. In his own case, they made a deduction of 1s. 6d. per 1000 cubic feet for the gas used in a fire, and they fixed a meter which the consumer had to pay for. If he did not want the meter after about twelve months, they bought it back, allowing him the price charged, less 10 per cent. for depreciation during the period named. He quite agreed with what Mr. Tooms had stated in regard to dealing with ironmongers; as also with what he said as to the absolute necessity for keeping an even pressure of gas throughout the 24 hours. He could not understand why people in these days should be troubling themselves as to whether they should keep on 10-10ths pressure at such and such an hour, or 20-10ths or 25-10ths, when they knew that on the other side of the water they were supplying gas at pressures of 40 lbs. per square inch. In his own experience at Nuneaton, they had 10 lbs. high-pressure mains, and they kept on a pressure varying from 18 inches to 5 lbs. or 10 lbs. The leakage had not been increased 1 cubic foot. It might be said that the present rate of leakage was too high; but they had just doubled the length of mains, and the leakage came out 40 cubic feet per mile per hour. He had made a list of a hundred different companies who published their leakage; and 40 cubic feet per mile per hour seemed to be about the average.

Mr. J. LYNE (Wexford) said the natural inference to be drawn from Mr. Tooms's paper was that the only places in Ireland where anything was done in the way of increasing the consumption of gas were in the group of associated towns given in Table I. He would undertake to show that the same work had been carried out in many other places. Mr. Tooms appeared to have a great horror of cheap gas, and seemed to be of opinion that any member supplying cheap gas should be expelled from the Institution. Referring to the quantity of gas consumed per head, he would instance Belfast, where the figure was 5487 cubic feet per head, as the highest. Belfast was a great manufacturing town, and it had also the advantage of cheap gas, of which Mr. Tooms thought so little. Next came Dublin, which covered a great deal of ground, and was not in any sense a manufacturing city, with a consumption of 4100 cubic feet per head. Then came Newry with 3700, Armagh with 3600, and Wexford with 3600 cubic feet; and then followed (in order) Cork, Lisburn, Dundalk, Waterford, Portadown, Mallow, and Middleton.

The PRESIDENT said Mr. Lyne's remarks were not exactly on the lines of Mr. Tooms's paper, which was as to the increase that had been obtained within a definite period in certain Irish towns. It was hardly necessary to refer to particulars of other towns.

Mr. LYNE said with regard to a gas company supplying fittings, it had been done in that city fifty years ago, when the Company established a show-room.

Mr. A. WILSON (Glasgow) said he was much indebted to the authors of the papers for bringing before the members the commercial side of their business; but it must not be forgotten that the other side was still important. When Mr. Goodenough said that the undertaking must not be merely a gas-supply business but a gas-service business, he really put the whole thing in a small compass. This view of the matter was certainly of comparatively recent date. For a long time, they were all trying to turn out as cheap gas as possible, without giving very much attention to the consumer. All this was now being altered; and they were very much indebted to Mr. Goodenough, among many others, for showing them the proper and reasonable way to forward this side of their business. With regard to ironmongers, gas companies had a comparatively free hand in dealing with them, because they could not "put the screw on" them in the same way that they could on corporation committees and their officials. Mr. Goodenough was a little contradictory in some places. In one case he said that no canvassing would do much good if the consumer had to be referred to a third party for the gas apparatus he was solicited to purchase or take up on hire. He (Mr. Wilson) should like Mr. Goodenough to give them some little idea as to how he dealt with the ironmongers. Would they only recommend people to come to the gas department for goods, and then get a commission, or would they actually supply the goods? They would all recognize that if third parties were to come into the business and do the supplying and fitting up, it would lead to some trouble. If they got their own men to do the fitting up, it was more likely to be done satisfactorily; and the same thing applied to inspection. The ironmongers had shown a great deal of apathy—not to say hostility—in the past; but if they were in a better frame of mind, and thought that something could be got out of it, and they could assist them to get something, while at the same time helping the gas department, he thought they would be acting on the right lines to take them into co-partnership. Mr. Goodenough referred to the ironmongers having an inducement held out to them to introduce gas to their customers. He (Mr. Wilson) should like Mr. Goodenough to be a little explicit as to what was the proper method to adopt in dealing with ironmongers. He did not mind confessing that he had a little personal interest in the matter, because his Gas Committee had had a memorial on the question from the trade; and it would be of great interest to the Committee, as well as to other departments, no doubt, to have as much information on the subject as possible. In the memorial to which he had referred, particulars were given of what the Ironmongers' Association had done to put their business in its proper light to gas companies. They said that in Manchester the Corporation did not do any work in gas-fitting, but left it to the ironmongers and plumbers. After referring to Croydon, they said the Gaslight and Coke Company had lately entered into an agreement whereby they allowed a special discount of 10 per cent. in the case of all gas consumers they sent to the show-rooms, as well as 10 per cent. off their gas bills for gas used in apparatus for show purposes, and a further 10 per cent. on all gas apparatus they were instrumental in getting supplied to a house. One of the suggestions made by the memorialists was that all orders booked by the gas officials should be handed over to the tradesman whose premises were nearest or most convenient to the consumer, provided that the latter had not expressed a preference for any other one. He did not know what his Committee would think fit to do in the matter; but he was sure that any information that could be given at this meeting would be a help to them. The point required the most careful attention from every gas engineer and manager, because so much depended upon it. Where the competition was keen, as it was in Glasgow, they wanted to hold their own by the best methods that could be devised. He thought, after hearing the gentleman from the other side of the water, they had something to learn on the point. Perhaps the methods adopted in America would not be applicable over here; but they could adapt them to their own circumstances as far as possible. He presumed that the readers of the papers only wanted to arouse interest in this question, both for their own benefit and that of other gas undertakings; and he thought the thanks of the members were due to them for the excellent way in which they had laid the matter before the meeting.

Mr. GOODENOUGH, in reply, said if his paper had had no other result than that of calling forth the observations made by Mr. Searle, it would not have been written in vain. He had watched with the very keenest interest what had been done in the way of pushing gas in the United States the last few years. He had gleaned most valuable information from the reports of the Commercial Section of the American Gas Institute; and he would recommend any of the members who could get hold of these reports to study them carefully. In reply to Mr. Cotton, he was very happy to say that the wealthier classes in the West-end of London constituted extremely good gas consumers (notwithstanding the competition of electric light), particularly for gas-fires. It was by the wealthy classes that the great saving of labour and wages effected by having these fires was chiefly felt. He instanced a house in South Kensington with 28 gas-fires—the whole of the cooking and heating being done by gas. The gas bill came to £120 a year; and the occupier of the house, who was an engineer, told him that the installation of gaseous

fuel meant a saving of two servants. There was not only the saving of their wages, but the coal bill, and the fact that everything destructible lasted so much longer than when they had dirty coal to deal with. He was glad Mr. Cotton supported the idea of co-operative advertising, but did not thank him for suggesting that he (Mr. Goodenough) should undertake it; nor did he think his Directors would thank him either, because he had sufficient to do at the present time. Local advertising was also very necessary. It was always difficult to trace the benefit obtained from advertising; but something might be done in this direction by "keying" advertisements. He was amused at Mr. Anderson's suggestion that the advertisements of his Company should be framed for use by other people. He endorsed what that gentleman had said about trusting good servants. They should give reasonable discretion to all their subordinate officers, and not "slate" them for errors of judgment in the same way that they would do for want of diligence. If they were always pulling a man up by the roots to see how he was growing, he would not grow very fast. With regard to special canvassers, his own men said they found that the previous acquaintance they had with the consumers was absolutely invaluable in the case of canvassing. It was found that house-to-house canvassing was not the success one might imagine it to be. The Londoner, at any rate, distinctly objected to such canvassing. With regard to Mr. Anderson's suggestion that gas-fires were costly in use, it was only a question of discretion in the gas company in advocating gas-fires—taking care not to recommend them where they would be used day in and day out, without pointing out to the consumer that they might be more expensive than coal. But he could not see that this was any argument against letting out gas-fires on hire. The lady demonstrators were not canvassers. They only made use of their opportunities occasionally, and never annoyed the consumer by pressing things upon him. Then they always called by appointment, as it was found that house-to-house visitation was not much good, because the call sometimes happened to be made when the kitchen was not in order. The consumers took great interest in the demonstrations, and frequently called in several friends; so that it became like a lecture to the whole neighbourhood. He did not think Mr. Anderson's suggestion that his Company should throw open their practical demonstrations to provincial companies was a practical one. As it was, their lecture-room was generally crowded; and if they did what was suggested, they would have to hire a town hall. Still the matter could be considered. With regard to the question of ironmongers being described as "agents," the Gaslight and Coke Company expressly forbade it, because they did not wish to be responsible for the work the ironmongers turned out. It was found that some ironmongers practically did no fitting work at all; they passed it on to the Company when they got orders. The Company fixed their prices so as to avoid underselling as much as possible. There were times when a special quotation was necessary; but the ironmongers quite appreciated this. He had not found that when the inspectors were doing canvassing they neglected other work. A record was kept of every complaint received from consumers in each inspector's district; and from this it would be seen at once whether the routine work was getting the attention it should receive. The inspector canvassing brought him into closer touch with consumers; so much so, indeed, that in some cases his house became a district office, with as many as a dozen callers in one evening. The Gaslight and Coke Company did not quite adopt Mr. Searle's system of recording everything in the house, but they recorded everything connected with gas. Mr. Searle's suggestion that, whenever work was done for nothing, an account should be sent in marked "No charge," was an excellent one; as was also the suggestion that letters should be obtained from all consumers saying whether they were satisfied. As a rule, consumers did not care to be troubled with writing such letters; but still they frequently got them. On a complaint being received from a consumer, when it had been attended to, they invariably followed it up by sending a report to this effect, with a statement that the Company would be glad to hear if any further cause of dissatisfaction arose. This formed a check on the men attending to the matter. He was glad to say that very few letters were received from consumers saying that they were not contented with what had been done. He quite agreed with the desirability of persuading the consumer to pay a large account, rather than satisfying him by cutting it down. During last March quarter, owing to the cold snap, they had had the heaviest output of gas for years. Gas-fires had been more generally used; and in almost every case they had been able to satisfy the consumer that he had had the gas for which he was called upon to pay. In very few instances had the meters been tested, because when this was done the consumer was seldom satisfied. In reply to Mr. George Helps, the Gaslight and Coke Company did not make a special price for gas used in gas-fires; and he had yet to be satisfied that there was any real justification for making a lower charge, because the demand for gas only came in the winter, and very little would be wanted if the winter happened to be a mild one. Referring to Mr. Tooms's paper, the increasing consumption in the towns in question was extremely satisfactory. It all depended on the degree of saturation at the commencement of such an increase as to the possibilities that could be achieved. It would be impossible, in a district like London, to achieve anything approaching what could be done in a place like Waterford, because there was a higher degree of saturation to start with. With regard to their treatment of the ironmonger, all they did was to endeavour to make it worth his while to use his own opportunities to get business—not to do the Company's work for them, but when he had the chance of introducing business to make it worth his while to do so. As a matter of fact, they allowed the ironmonger 5 per cent. commission on the net value of any stove he procured to be let on hire; 7½ per cent. if he succeeded in selling the apparatus on hire-purchase; and 10 per cent. if he sold it outright. In the case of a sale outright, the ironmongers took the money from the customer, and the Company sold them the stove at the net price, less 10 per cent. One of the great advantages of having these arrangements with the ironmonger was that one made friends with the trade. The question of having a uniform pressure on the supply mains throughout the 24 hours sounded simple enough; but the difficulty was, not to maintain the uniform pressure from the works, but to ensure that the pressure to the consumer would be constant at all times. The pulse of the district had to be felt very carefully in order to be able so to regulate the pressure on the mains that, whether the demand were great or less, the consumer always had the same pressure. He did not quite agree with Mr. Tooms when he said he was not in favour of single governors on the outlet of the meter to regulate the pressure of gas for totally different purposes. Mr. Tooms suggested that the consumer should have a uniform pressure at the inlet of his meter, but not at the outlet. He (Mr. Goodenough) did not follow him in this. With regard to the memorial Mr. Wilson had received from the Glasgow ironmongers, he would observe that disappointment probably awaited them if they expected to get all that they asked from the Gas Committee.

Mr. J. G. Tooms (Waterford) in the first place wished to thank Mr. Goodenough for his paper; and he thought the thanks of every member ought also to be given to him, not only for the paper, but for the progressive policy followed by the Gaslight and Coke Company during recent years. He (Mr. Tooms) ventured to say that very few gas undertakings represented there that day had not, either directly or indirectly, derived some benefit from the advertising methods practised by the Company. He was aware that even in Waterford advertisements of the Gaslight and Coke Company published in London periodicals had attracted attention; and he had taken the liberty of copying some of the advertisements into the local newspaper. With regard to his own paper, he felt rather disappointed that it had not received more criticism than it had. He wished to point out that nowhere in it had he expressed any opinion derogatory to cheap gas. No doubt cheap gas was what they were all striving for; but it was far from wise to give too much attention to this object, if by so doing more important matters were neglected. With regard to gas companies' dealings with ironmongers, he thoroughly agreed with what Mr. Wilson had said. The experience of their American friend justified his view, when he wrote his paper, that there was not much benefit to be derived from dealing with ironmongers. He had no objection to ironmongers selling gas apparatus. The advantage of the consumer dealing direct with the gas company was where he had a particular type of burner, and wanted a mantle for it, which could not be supplied by the ironmonger, who could not know all the circumstances. The advantage of the gas company keeping the business in their own hands, as he had found from experience, was that the whole of their consumers were educated to come to them in the event of dissatisfaction or any trouble, instead of keeping

their complaint to themselves. They could not have contented consumers unless they did the whole of the fitting business themselves. With regard to what had been said about pressure, Mr. Goodenough was probably in the habit of thinking of pressure in terms of inches, whereas he (Mr. Tooms) was accustomed to think of it in terms of tenths. In many towns, the minimum pressure might be as low as 7-10ths or 8-10ths.

## HIGH PRESSURE DISTRIBUTION DEVELOPMENT IN THE UNITED STATES.

**By R. M. SEARLE, of Rochester, N.Y.**

Since Mr. F. H. Shelton, of Philadelphia, read his paper on "High Pressure Distribution" before the Western Gas Association on June 15, 1899, the development of high-pressure distribution in the United States has been steady, sane, and satisfactory. The proper policy has become so familiar to those in touch with it that the growth goes along now with as little comment as one would give low-pressure distribution.

The author must confess ignorance of just what is being done in England, and for this reason may speak of certain things which are already familiar. Yet he hopes he may give encouragement to others who may be in doubt, and help guide them to economies and profit that now seem impossible. His idea in writing this paper was to direct attention to the developments which have taken place in high-pressure distribution work in the United States to bring it to the stage of perfection that now obtains; and he proposes to dwell more particularly on the appliances in use and the manner of using them, and, at the same time, if any members are sufficiently interested, he wishes to say that he has brought with him for the archives of the Institution copies of various papers read before the different Societies in the United States, which contain accounts of all the interesting things said and done in high-pressure distribution. They contain such a clear digest of the number of high-pressure installations in action, the number of consumers satisfactorily supplied, miles of main in use, &c., that he feels compelled to bring them to attention, though it would be unfair to take time to speak of them in detail. They are as follows:

"Distributing Gas Under Gas Pressure," by F. H. Shelton. Read before Western Gas Association, June 15, 1899.
"Pumping Gas Five Miles at 20 Pounds Pressure," by F. H. Shelton. Read before New England Association of Gas Engineers, Feb., 1900.
"Distributing Gas Under High Pressure," by F. H. Shelton *et al.* Read before Western Gas Association, May 16, 1900.
"Distributing Gas at High Pressure," by G. F. Goodnow. Read before Western Gas Association, May 22, 1902.
"Distribution of Gas at High Pressure," by F. H. Shelton. Read before Ohio Gaslight Association, 1902.
"High-Pressure Gas Distribution," by John A. Britton. Read before Pacific Coast Gas Association, 1903.
"High-Pressure Gas in Street Lighting," by J. J. Knight. Read before Ohio Gaslight Association, 1904.
"High-Pressure Gas Distribution of To-day," by H. L. Rice. Read before American Gas Association, Oct. 19, 1905.

He has also brought a volume of the "Proceedings" of the New England Association of Gas Engineers for 1902-1903, containing the following articles on this subject:—

"Distributing Artificial Gas at High Pressure in a Suburban Locality," by G. F. Goodnow and F. H. Shelton.
"Development of the Gas Distributing System in Revere and Winthrop, Mass."
"Notes on High-Pressure Distribution."

And a volume of the "Proceedings" of the Pacific Coast Gas Association for 1905-1906, containing the following:—

"The Compression and Transmission of Illuminating Gas," by E. H. Rix.
"Some Economies in High-Pressure Gas Transmission," by E. H. Rix.
"Experience with High-Pressure Gas-Mains," by Sherwood Grover.
"Some Economies in High-Pressure Gas Transmission," by E. H. Rix *et al.*

High-pressure distribution in the United States is generally understood to be 5 lbs. per square inch or over; and 50 lbs. per square inch in mains just before the peak-load comes on, is not uncommon.

*Pipe Used.*—In some of the earlier installations of high-pressure systems, before just what could be delivered by high pressure was understood, much 8-inch, 6-inch, and 4-inch pipe was laid, which, if the work were done over again, would be laid with 6-inch, 4-inch, 3-inch, 2-inch, and 1-inch. With but one exception, all those with whom the author has spoken agree that the best pipe to use under all circumstances is full-weight merchants' wrought-iron pipe, although Mr. E. H. Wetherby, the General Manager of the United Gas and Electric Company of New York, has in use about fifty miles of "Universal joint" cast-iron pipe, which

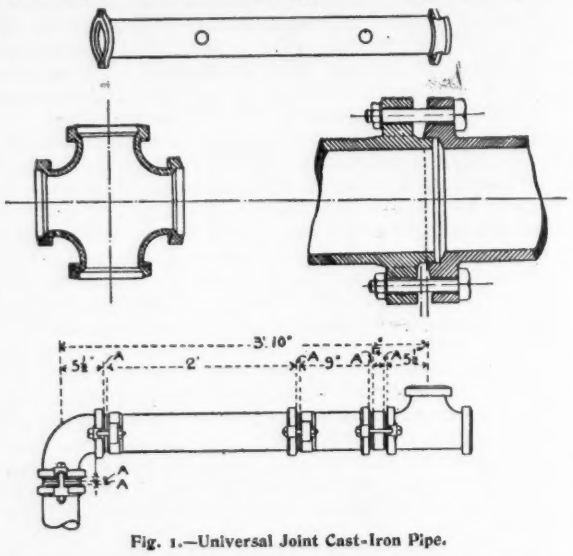



Fig. 1.—Universal Joint Cast-Iron Pipe.

has given such satisfaction that it is entitled to entrance into the high-pressure distribution fold; and for the information of those not familiar with this meritorious article, the writer has brought with him a sample of the pipe showing its chief characteristics (fig. 1). When laying wrought-iron pipe, heavy malleable recessed screwed couplings should be used; and it is important to have the joints well screwed home, also all threads thoroughly coated with red lead.

Developments have shown that gate-valves should be put in mains every half mile, and that expansion joints—preferably of the "Dresser" type—be put in every 1000 feet. In some of the original installations, this contraction and expansion was not provided for, and cast-iron valves and specials were pulled apart, which resulted in much serious loss, damage, and inconvenience. A sample of a "Dresser" sleeve as used in the States, also is exhibited (fig. 2).

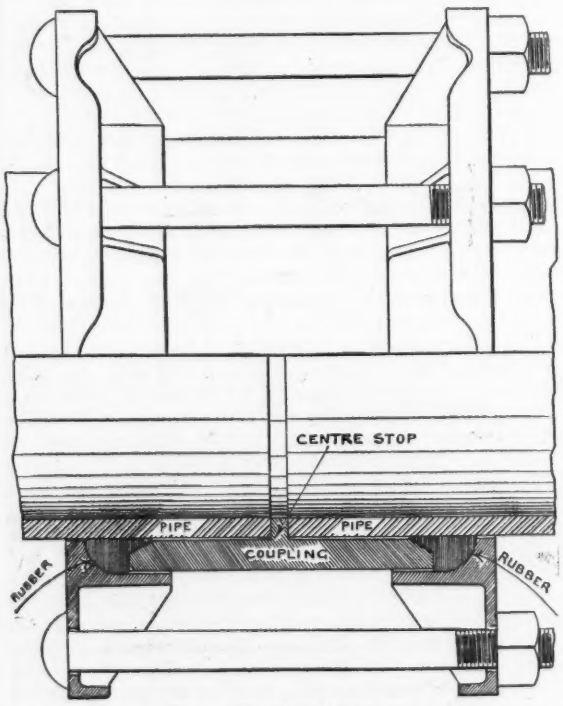



Fig. 2.—The Dresser Sleeve.

Where lateral mains are taken off the 4-inch or 3-inch direct trunk lines of 2-inch or 1-inch, they are connected

# EDGAR'S

Latest .
Leading
Lines . .

*1907 heralds the invention of* ☛

**EDGAR'S HIGH PRESSURE SYSTEM.**

EDGAR'S NEW PATENT FUEL "CERIA."

**EDGAR'S "WATERLOO" LAMP.**

EDGAR'S GOVERNOR.

*1907 heralds improvements in* ☛

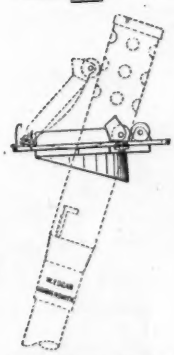
**EDGAR'S "CAXTON" STREET LANTERN.**

EDGAR'S "ECLIPSE" SHOP LANTERN.

**EDGAR'S "KING" SHOP LANTERN.**

EDGAR'S "BLENHEIM" GAS FIRE.

EDGAR'S (1907) IMPROVED ROLLER TRAP.



DOUBLE ANTI-FRICTION RUBBER BUFFERS.

WRITE . .

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# PARKINSON'S

## STATION METERS IN RECTANGULAR TANKS OF ELEGANT DESIGN.

## PARKINSON'S PATENT EQUILIBRIUM GOVERNORS.

These Governors are being used at a great many Works, and all Engineers speak of them in words of unqualified praise.

**FITTED WITH SIX COLUMNS and GIRDERS, WEIGHTS or WATER PRESSURE.**

PARKINSON AND W. & B. COWAN, LTD.,
(*Parkinson Branch*),
COTTAGE LANE, CITY ROAD, LONDON.
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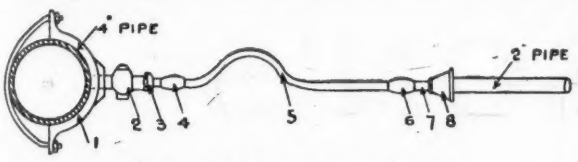



Fig. 3.—High-Pressure Service Saddle.

as follows: A high-pressure service saddle (fig. 3) is bolted on to the larger main, and a 1-inch extra-heavy brass corporation cock is screwed into it. The main is then tapped through the cock, and the cock shut off, when an expansion loop of 1-inch extra-heavy lead pipe is connected up between the trunk and the lateral (fig. 3). To quote Mr. J. D. Shattuck, the General Manager of the Suburban Gas Company of Philadelphia, who has charge of one of the large high-pressure distribution systems, and a pioneer in the United States: "The size of the hole tapped in the main should always be determined by the amount of gas probably required on such side lines or laterals. If any accident happens to the side line, it does not immediately draw out all the gas from the main trunk lines. When you consider that a ½-inch hole at 30 lbs. pressure will pass 500,000 cubic feet in twenty-four hours, you can readily see that you do not need a full-size opening into all side lines." All agree that the pipe should have at least 3 feet of cover; while many do not think it necessary to lay the pipe to grade.

*Drips.*—For large capacities, the main is tapped at the bottom, and a service saddle is put on. A pipe is then run to a suitable wrought-iron tank; a small pipe being brought to the level of the curb, where attachment is made to a drip waggon—the pressure of gas, of course, displacing any deposit that may be in the tank. For small-capacity drips, wrought-iron pipe is substituted for the tank.

*Pipe Coating.*—In the majority of cases wrought-iron pipe is coated with Hickenloper formula pipe coating before and after installing, which, for the sake of completing the record, is given below:—

The Hickenloper coating is prepared as follows: Bring a kettle of tar (20 gallons) to a low boiling point, and add 20 lbs. of fresh slaked lime, sifted over the top and worked down. Boil to a paste or consistency about midway between tar and pitch. Let it settle for a few minutes, then add 4 lbs. of tallow and 1 lb. of powdered resin. Stir until they are thoroughly dissolved, and incorporated with the tar, then let it cool and settle. Ladle off into barrels. When ready for use, to each barrel of 45 gallons of the above mixture, add 4 lbs. of crude rubber dissolved in turpentine to the consistency of thick cream. Heat mixture to about 100° Fahr., and immerse the service-pipe heated to about the same temperature.

*Capacity of Pipe.*—All the engineers who have undertaken the distribution of gas under the high-pressure system have been surprised, and, in fact, dumbfounded, to find how much gas can be pushed through a small pipe. The writer would caution those who contemplate introducing a high-pressure system to first study the formulæ for computing the flow of gas at high pressure. In so doing much money can be saved by laying the smaller sizes of mains, and just as good service is obtained. Many lean to the Pittsburg formula, which has been proven about correct; but the author finds that by using Cox's gas-flow computer he comes near enough for all economical purposes. The Cox, to his knowledge, is the only computer for this purpose in existence. Mr. Cox's formula on high-pressure fluid discharge is as follows:—

This computer solves the following formula, which is applicable to gas, air, and other elastic fluids flowing through long pipes with high initial pressures:

$$\left.\begin{matrix}\text{Discharge in cubic feet per hour}\\ \text{At atmospheric pressure}\end{matrix}\right\} = 33{\cdot}3\sqrt{\frac{d^5 \times (p_1^2 - p_2^2)}{L \times w}}$$

Where $d$ = diameter of pipe in inches,
$p_1$ = absolute initial pressure in pounds per square inch,
$p_2$ = absolute terminal pressure in pounds per square inch,
$L$ = length of pipe in miles,
$w$ = specific gravity of the fluid when air = 1.

*Cox's Gas-Flow Computer.*
(For Low Pressures.)

This computer solves Dr. Pole's well-known formula for the flow of gas in pipes.

$$\text{Discharge in cubic feet per hour} = c\sqrt{\frac{d^5 \times (p_1 - p_2)}{l \times w}}$$

Where $d$ = diameter of pipe in inches,
$p_1$ = initial pressure in inches of water,
$p_2$ = terminal pressure in inches of water,
$l$ = length of pipe in yards,
$w$ = specific gravity of the gas when air = 1,
$c$ = a constant varying from 1000 to 1350.

*To Find the Discharge from a Pipe and the Required Size of Pipe.*

(1) Set the specific gravity of the gas oppposite the selected constant.
(2) Bring the difference of pressure ($p_1 - p_2$) opposite the given length of pipe.
(3) Opposite any diameter of pipe will be at once found the discharge in cubic feet per hour.
(4) Opposite any desired discharge will also be found the required diameter of the pipe.

On this gas-flow question, a letter from Mr. H. L. Rice, the General Manager of the Western United Gas and Electric Company of Aurora, Illinois, may be quoted:

The Pittsburg formula, which is apparently the best high-pressure formula yet presented, is very interesting. I have been told that the curve of gas flow is the parabola, but have not gone into this. I do not think it is so. The most important point is, of course, that it is absolutely true, that as the initial pressure increases in reference to any fixed final pressure, the gas transmitted becomes more and more in direct ratio to the increase in pressure. The amount of gas transmitted is directly as the square root of the differences of the squares of the two pressures, initial and final; and as the initial pressure becomes very great, the final pressure is more and more negligible in comparison, so that we have the amount of gas transmitted being directly as the square root of the square of the initial pressure. This is an important point, as it is the justification for increases in pressure, and will be the justification for very high pressures if other considerations will allow us to come to them.

Further examination of the formula along these same lines show that you can transmit almost as much gas with a final pressure of 10 lbs. as you can with a final pressure of a few inches of water; hence there is no increase in the cost of transmission lines in serving distribution centres with direct high pressure. This is an important point also, because if it didn't work out this way, all the saving you might make in your distributing direct high-pressure system you might lose in the line for transmitting gas to the centre of distribution, and having to deliver it at a higher terminal pressure.

There are a few points which I think are interesting, and would like to see elaborated. The Pittsburg formula is standing the test of time and experience. Of course, more experiments would be of value, such as we have so far show that this formula is right.

With regard to our actual work the last year or two, will say that our high-pressure experience has been quite uneventful. We have had practically no troubles whatever, and have made no advancement in the art, except in some very mild particulars, such as little wrinkles. We have abandoned the stop-cock entirely at the mains, believing this to be a source of weakness. We use the T-saddles; and we have our own device for shutting off the gas while laying the service. This is a small tool, of which I send you a blueprint. (See fig. 4.)

We have started recently some experiments on condensation from compression, and I enclose you the results of these, although they are so preliminary that only the most general results can be drawn from them. There is condensation of water, as would be expected, and there is also some oil. This oil is a limpid light coloured oil with a most powerful odour—that of drip liquor many times concentrated. It is highly inflammable, and can doubtless be used for enriching purposes, although we have not gone this far. Gas at comparatively low pressure will doubtless pick up this oil condensed at a higher pressure.

At Elgin, we have a tank near the works. Occasionally the gas is passing at high pressure toward Aurora through this tank. Again, the gas is coming to the Elgin works from Aurora and is consequently at lower pressure when it reaches this tank. Now, you will observe that the oil per 1000 in the Elgin report is much less than in the Joliet report. The only reason we can give for this is that a large part of this oil, condensed at high pressure from the Elgin gas, has been reabsorbed by the Aurora gas coming to Elgin. Mr. Wheeler, of the Semet-Solvay Company, agrees in this conclusion.

Now in regard to the removal of condensation. You will recall that at Milwaukee it was not generally agreed that this problem had been solved. Nevertheless, I think it has, and that it is a very easy matter to rid the high pressure gas of its condensation within a reasonable distance from the works, so that no further deposit of water or oil need be feared. Of course, as the gas expands it begins to be in a condition to absorb moisture. Therefore, the only problem is to shake out all the moisture that will go down at the initial pressure. The first experiments in this line were baffle tanks. Mr. Goodnow built one of these at Waukegan; and we built one on exactly the same lines, as already mentioned, at Elgin.

Last winter we had a lot of condensation develop on a new line to Dundee, and it was necessary to do something at once. The people all along this line were out of gas, and their services full of water. The thought struck me: Why not put in practically a steam separator? It occurred to me that this was simply a questionof velocity, and that we should treat this gas just the same as we treat steam in freeing it from water. As the Cochrane is one of the best, I placed an ordinary 8-inch cross in this 3-inch line, connected the bottom of this cross into a leg below the frost line, and plugged the top of it with a plug to which I had fastened a plain

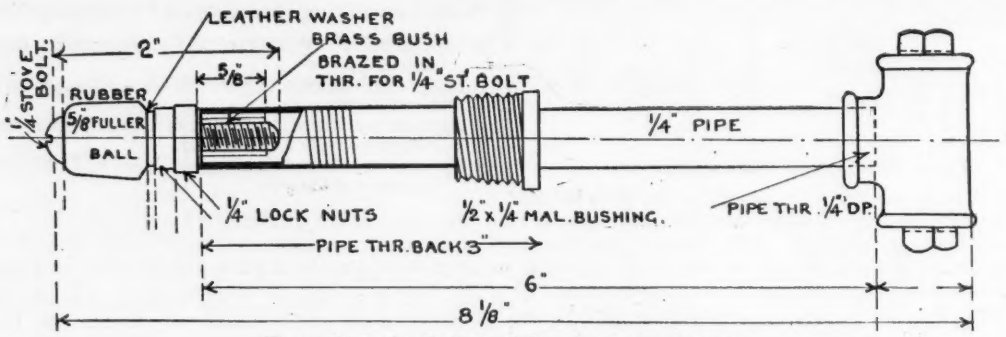



Fig. 4.—Device for Shutting-off Gas while Laying Services.

sheet-iron baffle, just like the baffle in the steam separator, only not corrugated. This little rigging cost only a few dollars, and cleared up the water trouble for good in that line. It was placed at the bottom of the first hill going out from the gas-works.

You might make a point of the ease with which one can separate moisture from the initial high-pressure gas, and that it can be done on the same principle as steam separators; and all that is necessary is to put one of these separators out on the line at the first low point beyond these lines. There will be no trouble beyond, as the gas will begin to expand.

Replying to your inquiry as to the number of miles of main, and the number of consumers that we have, I beg to advise you as follows: We make a distinction between the pipe-line and the high-pressure distributing mains. We have the following pipe-line in use:

| | | | |
|---|---|---|---|
| 8-inch | 16 miles | 3,920 | feet |
| 6 „ | 20 „ | 274 | „ |
| 5 „ | 1 „ | 4,820 | „ |
| 4 „ | 51 „ | 345 | „ |
| 3 „ | 13 „ | 4,483 | „ |
| 2 „ | — „ | 3,120 | „ |

*High-Pressure Distributing System.*

| | | | |
|---|---|---|---|
| 2-inch | 9 miles | 323 | feet |
| 1½ „ | 34 „ | 4,139 | „ |
| 1¼ „ | — | 207 | „ |
| 1 „ | 21 „ | 3,251 | „ |
| ¾ „ | 3 „ | 3,672 | „ |

As for the number of consumers, I do not know whether you mean direct high pressure or with high-pressure gas. The subject is best covered in this way: We send more or less high-pressure gas around to all our cities and towns—even those that have manufacturing stations and holders get some high-pressure gas occasionally, if it is necessary to help out the stock of gas. All the works and holders are connected to the pipe-line.

So much for the four main towns—Aurora, Elgin, Joliet, and La Grange, and also La Grange Park and Grossdale—which are served by low-pressure from the La Grange works. Total meters in this group, 17,884.

| | | |
|---|---|---|
| North Aurora is served by direct high-pressure, and has | 110 | Consumers. |
| Naperville, by direct high-pressure, has | 430 | „ |
| Batavia, high-pressure gas reduced through a district governor and low-pressure distributing system | 643 | „ |
| Geneva, the same | 331 | „ |
| St. Charles, the same | 587 | „ |
| Hinsdale, the same | 595 | „ |
| Downers Grove, the same | 482 | „ |
| South Elgin, direct high pressure | 73 | „ |
| West Dundee | 243 | „ |
| East Dundee | 83 | „ |
| Carpentersville | 52 | „ |
| Plainfield | 191 | „ |
| Lockport | 276 | „ |
| Western Springs | 148 | „ |
| Wheaton | 536 | „ |
| Elmhurst | 280 | „ |
| Lombard | 105 | „ |
| Glen Ellyn | 239 | „ |
| West Chicago | 335 | „ |

Of course, you know our ultimate plan is gradually to consolidate all our manufacturing in one station; and when this is done, all the gas delivered will be gas that has been compressed, with the exception of the gas that will be delivered in the city where the big plant is located.

We are beginning to do quite a little reinforcing in our low-pressure districts from the high-pressure mains. In Aurora, for example, the pipe line comes into the city right through the heart of the district where the pressure is weak on the outskirts. We expect to wing-out two 4-inch mains on each side of this pipe line right through this weak area, and set governors at various points to reinforce and help carry the peak-load of the low-pressure system. We have not yet decided on the governor to use. We have experimented with a number, and probably will have one of our own design made. As far as we can see ahead now, we will not depend on one governor, but will set a bank of comparatively small governors in each manhole. I am not prepared to go into the reasons for this at the present time, nor are we far enough advanced in our work; but we do feel sure we are going to get some very effective boosting.

Of course, this idea of boosting with the higher pressures is not novel. I believe that they have used it most extensively in California. In the East, the tendency has been, I believe, to use lower pressures. In this connection, I will say that I heard the other day that the B. F. Sturtevant Company have now a very successful rotary blower on the market that is efficient at 10 lbs. You will remember that Mr. Baehr gave as the reason for using 5 lbs. at St. Louis that they wanted to use rotary blowers, and these were not efficient above 5 lbs. It might pay you, therefore, to write B. F. Sturtevant Company about this blower. I have been intending to go into it with them, but have not as yet had the time.

We do not know nearly enough yet about the loss in candle power and heat units in compressing and in transmitting high-pressure gas. There is some loss, of course; and we know it is less with coal gas than with water gas. The oil above mentioned as squeezed out of our coal gas represents some candle power. We expect to make some experiments on this subject, but have them as yet before us, and, therefore, I regret not being able to give you some information on this important subject.

In general, I will say that an ordinary good quality coal gas can be compressed to 40 lbs., and delivered fifty miles to consumers and give satisfaction. I am speaking of the ordinary community using gas ranges and doing its lighting largely with incandescent mantles, but with occasional open flames. The open flames will not be as good as with the gas before compression; but they will pass. The heating quality will be entirely satisfactory. At pressures of 20 lbs., or thereabout, the open flames will be very little (if any) impaired. I am now speaking very generally, of course, for, as above stated, we have yet our accurate experiments to make.

I have written considerably at length, and have not managed to tell you very much. The principal thing is that we are going along successfully, and having no more troubles in high-pressure distribution than in low—in fact, I do not think we have quite as many.

### Elgin Observations.

*High-Pressure Drippage Data—Station "D."*

| | | |
|---|---|---|
| Duration of Pumping Jan. 21 to Jan. 28 inclusive Actual time from high-pressure charts | 114 | hours. |
| Gas pumped | 1,237,301 | cubic feet. |
| „ per hour | 10,850 | „ |
| Temperature of gas at inlet of compressors | 65° | |

*Four-Inch Line South.*

| | | |
|---|---|---|
| Gas pumped during period | 1,095,901 | cubic feet. |
| Clear oil from from drip during period | 80 | gallons. |
| Liquor from drip during period | 22 | „ |
| Condensation—total | 102 | „ |
| „ per million cubic feet of gas pumped | 93 | „ |

*Three-Inch Line North Dundee.*

| | | |
|---|---|---|
| Gas pumped during period | 141,400 | cubic feet. |
| Clear oil from drip during period | 45 | gallons. |
| Liquor from dip during period | 11 | „ |
| Condensation—total | 56 | „ |
| „ per million cubic feet of gas pumped | 392 | „ |
| Condensation—both 3 inch and 4 inch lines—per million cubic feet of gas pumped | 158 | „ |

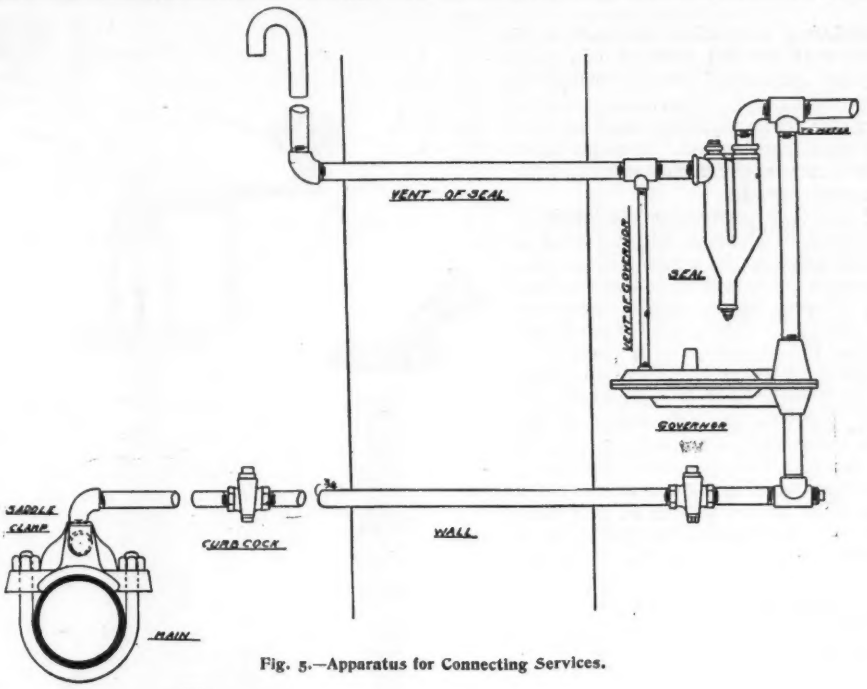



Fig. 5.—Apparatus for Connecting Services.

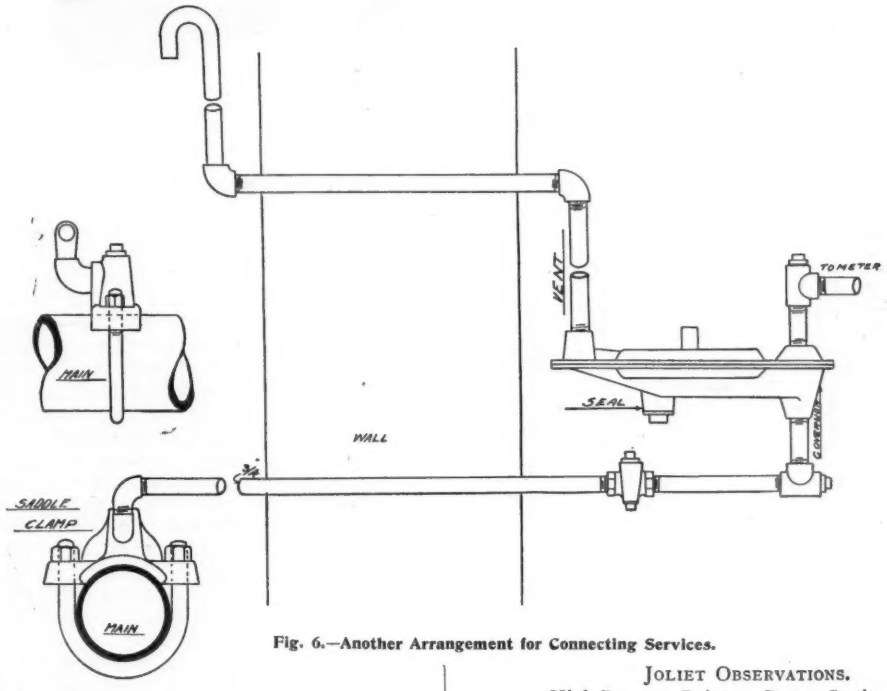



Fig. 6.—Another Arrangement for Connecting Services.

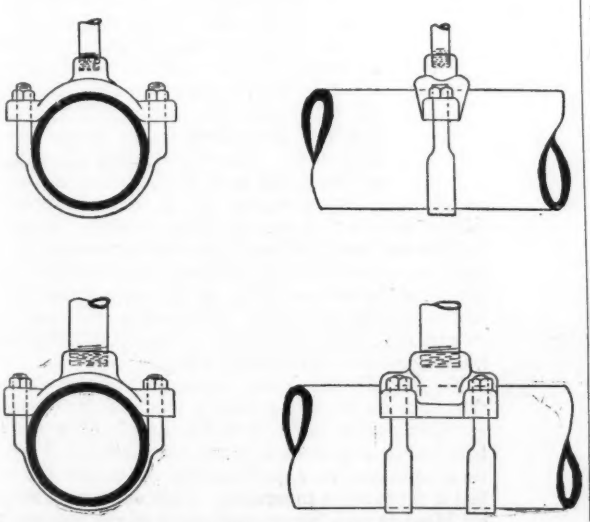


Fig. 7.—The Fittings used in Service Work.

JOLIET OBSERVATIONS.

*High-Pressure Drippage Data—Station "B."*

| | |
|---|---|
| Duration of pumping—7.15 a.m., Jan. 21, to 5 p.m., Jan. 24 | 81¾ hours. |
| Gas pumped by No. 1 Compressor (new), 41½ hours, at 15,200 cubic feet per hour | 630,800 cubic feet. |
| Gas pumped by No. 2 Compressor (old), 73½ hours, at 13,300 cubic feet per hour | 974,225 „ |
| Total gas pumped during period | 1,605,025 „ |
| Temperature of gas at inlet of compressors—variation 68° to 74°. Average of 18 readings | 70·6° Fahr. |
| Temperature of gas at outlet of compressors—variation 180° to 217°. Average of 9 readings | 191·0° „ |
| Clear oil from drip during period | 157·5 gallons. |
| Emulsion of oil and water during period | 104·4 „ |
| Total condensation during period | 261·9 „ |
| Clear oil per million cubic feet of gas pumped | 98·1 „ |
| Emulsion per million cubic feet of gas pumped | 65·0 „ |
| Total condensation per million cubic feet of gas pumped | 163·0 „ |

REMARKS.—No regularity in amounts of oil and of emulsion per 1000 cubic feet of gas, nor in relative proportion of oil to emulsion from day to day.

Also a distinct difference noted in colour of oil samples taken different days.

*Services and Methods of Connection.*—It seems to be generally agreed that for the sake of additional safety, only beaded galvanized fittings should be used on the high-pressure side of services; while on the low-pressure side all or anything found suitable for low-pressure work may be used. Services on the low-pressure side of service governors are treated the same as low-pressure services.

A galvanized iron high-pressure saddle (made by H. Mueller and Sons, of Decatur, Ill.) is bolted on to main; the joint between the saddle and the pipe being made gas-tight by means of a lead washer, which sets into a recess in the saddle, and is furnished with a saddle. This saddle has $\frac{1}{2}$-inch wrought-iron pipe thread holes in it; a $\frac{1}{2}$ inch beaded galvanized street T screwed into the saddle, and a $\frac{1}{2}$ inch by $\frac{3}{4}$ inch beaded galvanized iron reducing street L put into the side outlet of the street T to make the swing joint. A $\frac{3}{4}$-inch pipe is run to the curb, and one of Mueller and Sons' heavy high-pressure service cocks is put on at the curb. This cock has a bore at the bottom of the plug $\frac{3}{16}$ inch in diameter. The main is tapped with a hole $\frac{1}{4}$-inch through the $\frac{1}{2}$-inch street T. The service is then carried through the cellar wall, and a lock meter cock is put on. A $\frac{3}{4}$-inch pipe is then run to the governor and safety seal. The vent of this seal is piped to a suitable place out of doors. Beyond the governor all the work and supply is treated as though a low-pressure gas system were in use. When the gas blows the mercury safety seal, it makes sufficient noise as it issues from the vent to attract immediate attention, and a whistle is not necessary.

Figs. 5 and 6 illustrate how the services are connected, and fig. 7 shows the character of the fittings used in service work. Samples of service saddles, lead gaskets, and cocks most used in the United States are also exhibited. The latest method of connecting services—and one which the author thinks will now become standard—is to place on the main a service clamp or saddle, which has a top and side outlet, and is a T and service saddle all in one piece. This does away with one thread, and gives a much stronger connection to the main. In this case, the main is tapped only $\frac{3}{16}$-inch without the use of a corporation cock, a curb cock, or an inside service cock, with the use of a $\frac{3}{4}$-inch cock with a $\frac{1}{2}$-inch round-way in the plug only. This enables the blowing out of the service, and overcomes the difficulty of stopped services, which gave some trouble under the old system.

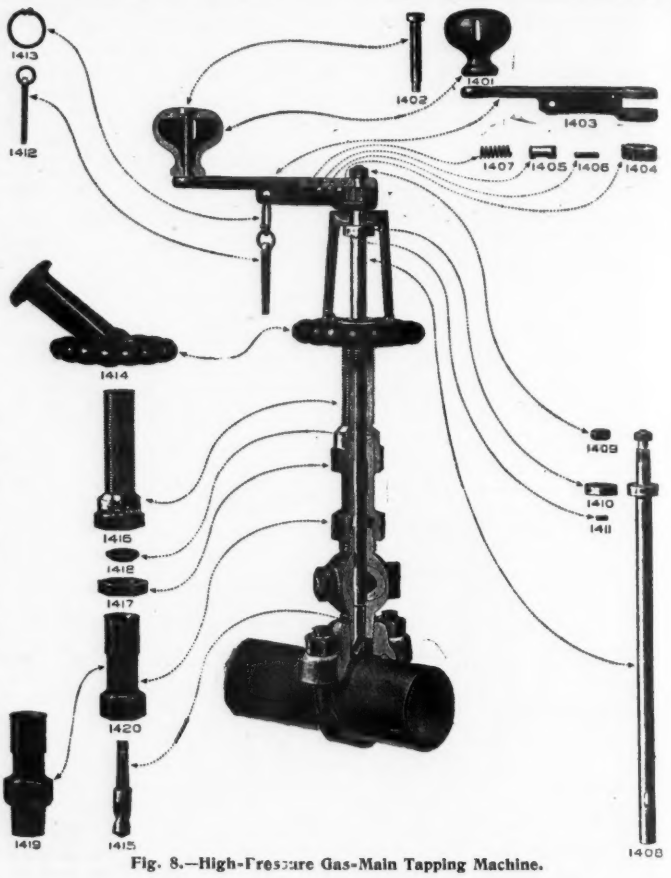


Fig. 8.—High-Pressure Gas-Main Tapping Machine.

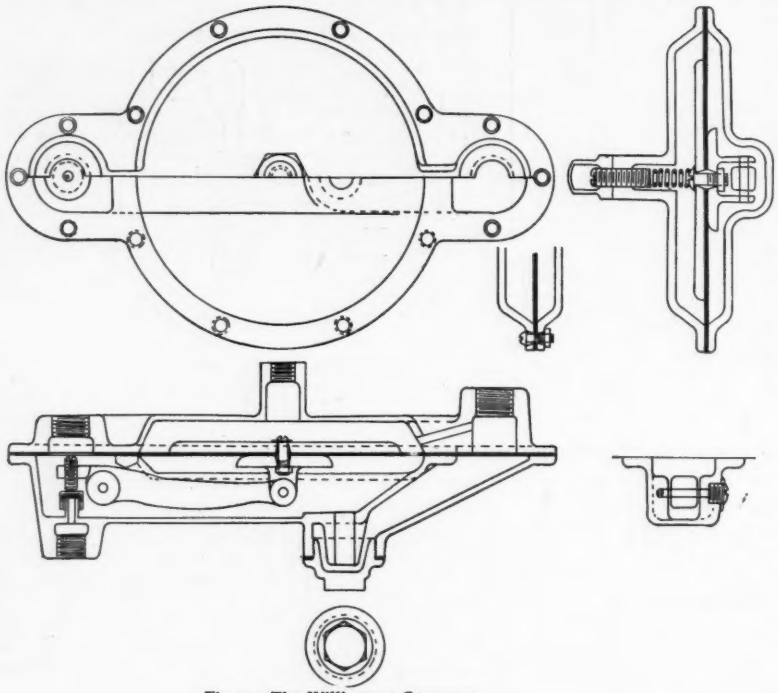


Fig. 9.—The Williamson Governor.

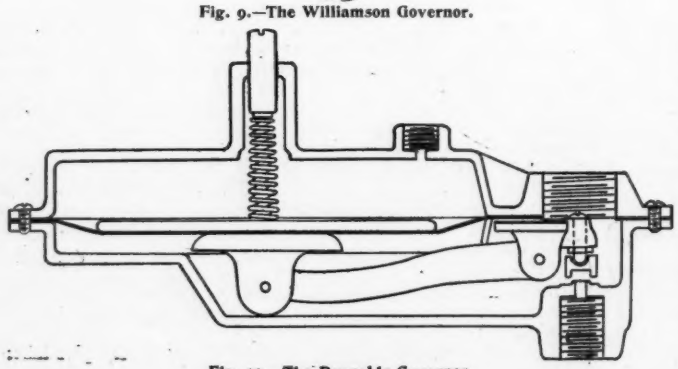


Fig. 10.—The Reynolds Governor.

If the stoppage occurs right at the opening in the main, a force pump will easily blow away any stoppage that may accumulate there. There seems to be a tendency for particles of foreign matter to deposit in the services, which, in the old-style service, was very difficult to get rid of, while with the small main-tap much of it remains in the larger pipes or mains. Another decided advantage of the small hole in the main is that it prevents a large escape of gas in case of a broken service or of a broken pipe inside a cellar. A small hole in the main will not permit much more gas to pass than would in an ordinary low-pressure service, and therefore gives a much more direct control of the high pressure. The author wishes again to call particular attention to fig. 6, showing the latest system of connecting services.

*Tapping Machine.*—An interesting little device that is used in high-pressure work is the tapping machine shown in fig. 8, and a sample of which is brought as a present to your Association. This is so simple and so ingenious that the writer did not feel it quite right to omit it. This machine is made by Mueller and Sons; and much of the success in

high-pressure distributing work in America is due to their untiring efforts to perfect devices to help us to develop the business, and to carry out the ideas of various engineers.

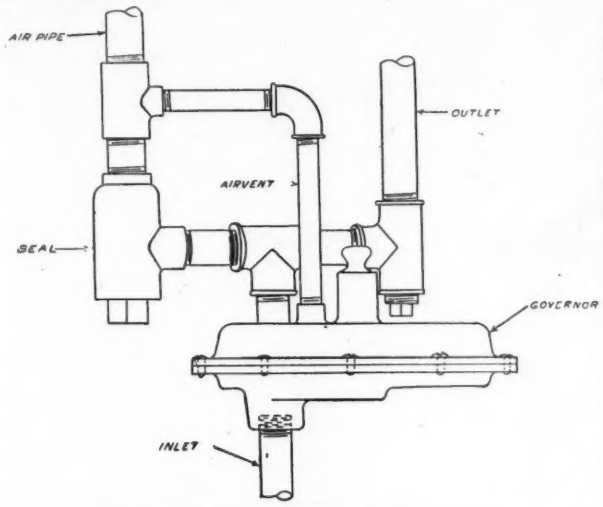



Fig. 11.—The Connections for a Reynolds Governor.

The author would at once say he believes in giving full credit to all those who have done so much for the gas business at large.

*Service Governors.*—Many types of governors have been offered for this purpose; but most of our engineers have settled upon three types, each of which will now be described: The Williamson governor, invented by C. W. Bradley, the Chief Engineer of the North Western Gas and Coke Company, Oak Park, Illinois, has the many advantages of earlier types of service governors, and the additional advantage of combining the mercury safety seal with the governor body, which saves many small fittings and much time and cost in its installation. Fig. 9 illustrates this governor, and a sample is also exhibited.

The Reynolds governor is shown in fig. 10, and is much like the Williamson, having its large share of admirers. A sample of this governor is also exhibited.

The double district governor and Reynolds's plan for installation in district and manhole work is shown in fig. 11.

### Description of District Governor.

Referring to fig. 12, the governor is double, so that all parts marked $C^1$, $D^1$, $E^1$, &c., are duplicates of the parts marked simply C, D, E, &c., and refer to the duplicate side of the governor, which is ordinarily out of use, being a reserve only. It will therefore be necessary to consider one side only in describing the action of the governor.

In the following description only one side—*i.e.*, bearing the simple lettering C, D, E, &c.—will be considered; it being understood that the opposite, or duplicate, side is shut off.

Assume that valves C, D, E, and F are open and G properly set. A is the main inlet carrying gas under a variable pressure of any number of pounds. This gas passes through the valve C to the main governor H, where its pressure is reduced to the ordinary "street pressure" and delivered through the valve D into the low-pressure network of mains beginning at B.

In order to properly control the large volume of gas passing through H, and reduce it from a *variable number of pounds* at the inlet to *constant number of tenths of inches water pressure* at the outlet, a very nice adjustment is required; and this is effected through the medium of the bowl I.

The secondary governor K has a removable cap, so that weights may be added or removed—thus giving any desired pressure in tenths of inches of water at its outlet; this outlet being connected to the street main B. It follows, then, that whatever, the pressure is at B, that same pressure will obtain at the outlet to K, and any rise in pressure at B will therefore cause K to close.

The supplemental high-pressure governor J reduces the pounds of pressure (variable) at A to a constant pressure less than at A, but always greater than at B or at the outlet of K. J is usually set at about 10 inches, so that when K is closed the pressure in I increases to 10 inches, closing H absolutely tight.

The needle-valve G permits the gas coming to it from J, under a constant pressure of 10 inches, to flow to the secondary governor, K, and thence to the low-pressure main, *and at the same time* exert a pressure upon I, through N; thus tending to close the main governor H and reduce the flow of gas to the street main B.

Now, in case the pressure at B tends to rise on account of diminishing consumption of gas, the secondary governor K will instantly begin to close. Thus the pressure in the small pipe between G and K will increase, and will, in turn, throw pressure upon I and assist in closing the main governor H. On account of the large area of I, this action will be *positive and absolutely effective.*

If the consumption becomes very small, the main governor will close entirely, and will be firmly held in that position; while the, extremely small consumption is cared for by K. The instant however, that K is unable to deliver sufficient gas to B, at the desired pressure, a deficiency of pressure will obtain in the small pipe between G and K (referred to elsewhere). This deficiency will be apparent at I, and the main governor will be opened by the weight M.

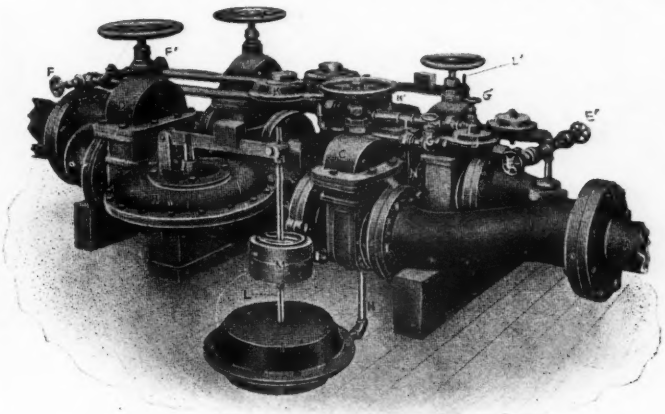


Fig. 12.—The General Arrangement of Reynolds Governor Connections.

Key to Parts.

A. Main high-pressure inlet. B. Main low-pressure outlet. C. Main high-pressure gate-valve. D. Main low-pressure gate-valve. E. Supplemental high-pressure angle-valve. F. Supplemental low-pressure angle-valve. G. Needle-valve regulating flow to I and K. H. Main governor for maximum flow. I. Auxiliary pressure bowl acting on main governor. J. Supplemental high-pressure governor. K. Secondary governor for minimum flow, and by means of which any desired outlet pressure in inches of water may be obtained. L. Connecting rod. M. Regulating weights. N. Pipe carrying partially reduced pressure to auxiliary bowl I.

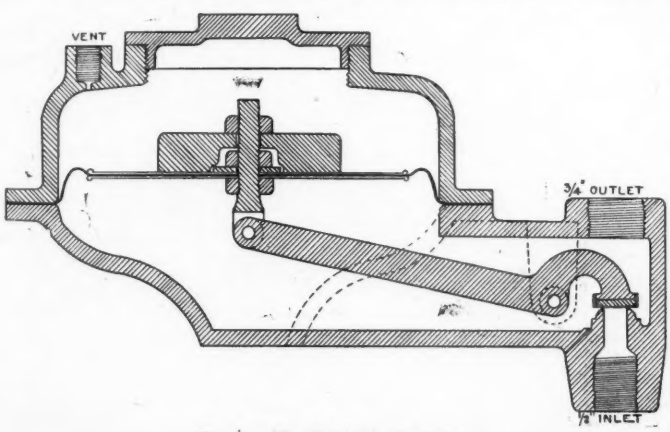



Fig. 13.—The Equitable Governor.

The Equitable governor is another type satisfactorily and extensively employed, and is used with a separate mercury seal (see fig. 13 and sample exhibited).

*Charts.*—To show the very satisfactory work done in high-pressure distribution in the United States, the author wishes to call attention to the seven charts submitted (pp. 942-3). Chart "A" shows the pressure on the line at the compressor station at Chester, Pa. Chart "B" shows the pressure on a high-pressure line 12 miles away at Media, Pa. Chart "C" shows a pressure beyond the house governor at Media, Pa., 12 miles from compressor station. Chart "D" shows the pressure at the compressing station at Evanston, Illinois. Chart "E" shows the pressure on the high-pressure line at Barington, Illinois, thirty-eight miles from the pumping station. Chart "F" shows the pressure on the condenser side of the Williamson regulator eight miles from the Evanston compressor station.

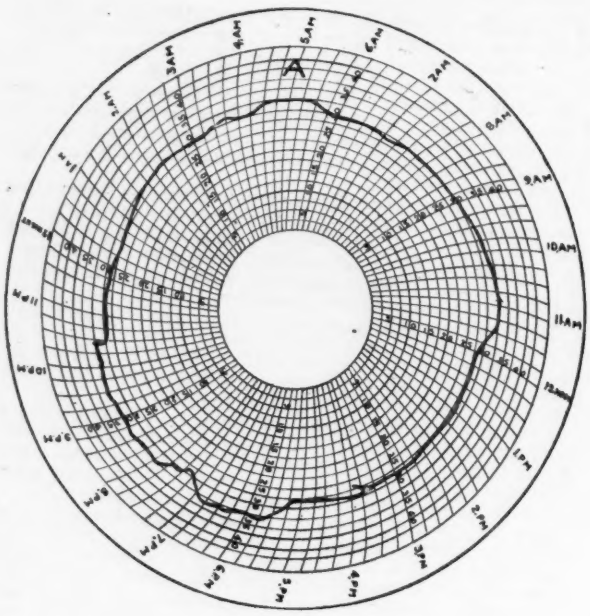



Chart A.

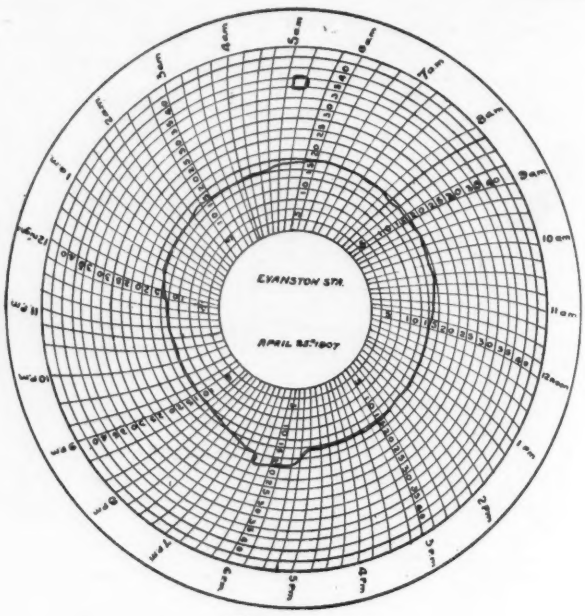



Chart D.

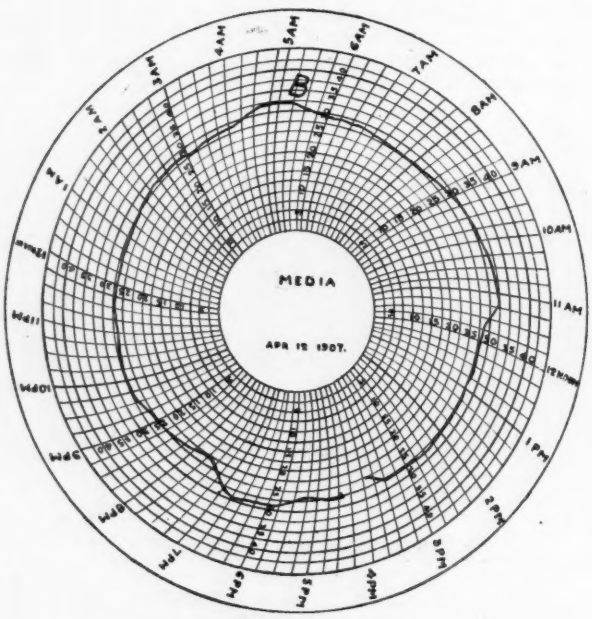



Chart B.

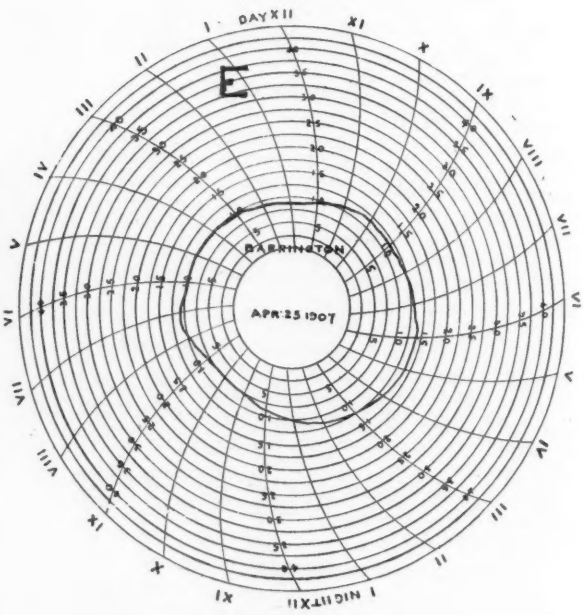



Chart E

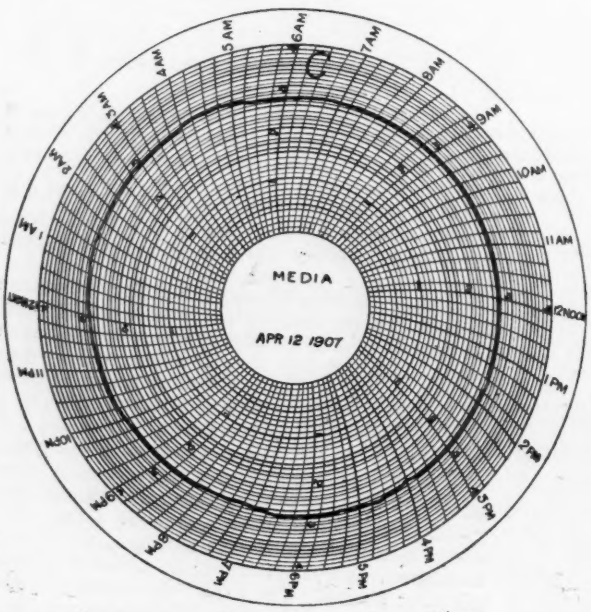



Chart C.

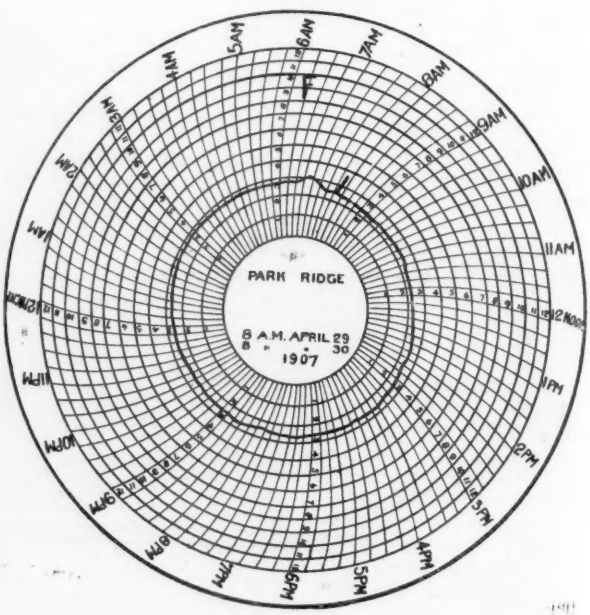



Chart F.

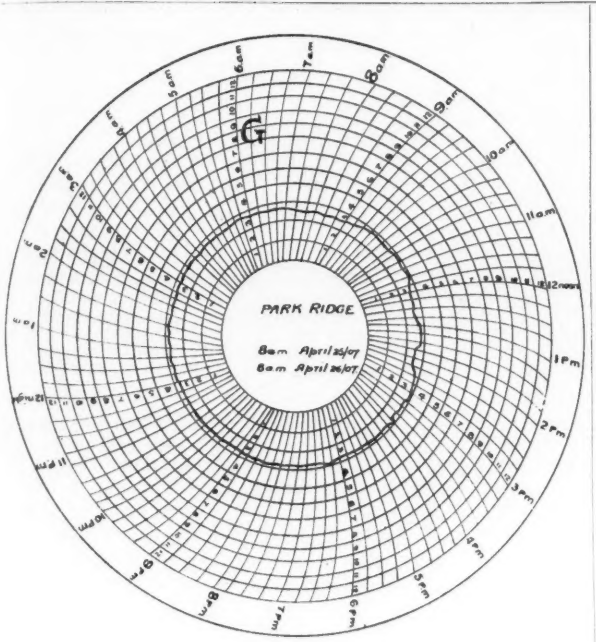



**Chart G.**

Chart "G" shows pressure at the same point taken as a check, charts being taken one week apart. The results obtained, as shown by these charts, are most convincing. If the maintenance, &c., of a high-pressure installation is calculated, the care of the governor and diaphragms must be taken into consideration. The writer certainly thinks the diaphragms need oiling periodically and systematically, and they should also be carefully inspected; for he believes the fewer services that blow, the better the reputation of a high-pressure system will be.

*Safety Seals.*—Of course, the safety seal or safety vent on a high-pressure service is of the utmost importance. This vent pipe should be taken out of doors. The end of the pipe should not carry any threads, and should be out of the reach of everyone, so that it would be impossible for it to be plugged with a cork and a piece of wood. If the drawings of the various governors and service connections submitted herewith be examined, it will be seen that the safety seal requires no further explanation.

*Compressors.*—The question of which compressor to use is still under discussion by our best engineers. At 5 lbs. to 10 lbs. many prefer the rotary blower, single or tandem; above this, they jump right into any type of air compressor that can be adapted to gas compression purposes. But to show how flexible the compressor situation is, the writer may mention that a Westinghouse air compressor is fastened to the side wall of the exhauster room of the North-Western Gaslight and Coke Company at Evanston, Illinois. This cost about $200·00 installed, and supplies 38 miles of high-pressure main, on which they have 1400 consumers. This compressor runs twenty-four hours per day, building up a pressure of 35 lbs., which drops to 12 lbs. at the end of the peak-load; the large amount of pipe acting, as it does in all cases, as a storage for free gas. One could well afford to have three or four of these compressors in just any clean place in a small works, and have a perfectly satisfactory emergency outfit at a minimum cost of equipment.

*Pulsation and Storage Tanks.*—To those sufficiently interested to go into this section thoroughly, the writer would suggest the perusal of the paper on "High-Pressure Gas Distribution of To-day," written by Mr. H. L. Rice, of Aurora, Ill., for the thirty-third annual meeting of the American Gaslight Association held on Oct. 18, 1905, which covers the subject so thoroughly that the author does not want to pass it over without calling attention to it. Present developments point to the further introduction of wrought-iron cylindrical tanks at the extreme ends of the mains, which are used as holders to feed back on the peak-load; and their great economy and usefulness must appeal to you all.

*Loss in Candle Power.*—For a long time nothing definite could be obtained on the question of the loss of candle power due to compression and transmission; but from recent investigations the writer is satisfied that this is a factor which must be reckoned with. Some very reliable data showing a drop of 11 per cent. at 5 lbs. was observed for gas transmitted 8 miles, which was about double the loss of candle power of the same gas sent out 8 miles on the low-pressure system.

*Complaints.*—As a matter of great interest, the author quotes a letter received from Mr. C. W. Bradley, the Engineer of the North-Western Gas and Coke Company, Oak Park, Illinois, in regard to a particularly severe winter. Considering the climatic conditions referred to, the record, it will be admitted, is a most excellent one.

"The enclosed record of complaints are *all* the troubles we have had on the line between the given dates. You will find on the enclosed sheet the size, mileage, and number of services in the territory covered by these complaints. You will notice that there are no leaks at the expansion joints, and that the total number of complaints is small compared with the territory supplied."

*Record of Complaints received on Evanston High-Pressure Line from Edison Park to Barrington, from Dec. 22, 1906, to March 19, 1907.*

| | |
|---|---|
| Broken curb cock | 1 |
| Changed location of service | 3 |
| Loose saddle | 19 |
| Leak at long screw | 1 |
| Pipe punctured | 1 |
| Core of curb cock loose | 1 |
| Leak at coupling | 2 |
| Street T broken | 1 |
| Service sagged | 1 |
| Regulator leak | 3 |
| Williamson 2 Equitable 1 | |
| Regulator valve frozen | 4 |
| Williamson 2 Equitable 2 | |
| Regulator valve dirty | 4 |
| Equitable 4 | |
| Leak at regulator diaphragm | 2 |
| Equitable 2 | |
| Regulator valve broken | 1 |
| Equitable 1 | |
| Water in regulator—service sagged | 1 |
| Regulator diaphragm worn | 1 |
| Equitable regulator 1 | |
| Poor supply—air vent stopped | 3 |
| Equitable 3 | |
| Total | 49 |

*Record of Mains Laid and Services run from Madison Park to Barrington.*

| Town. | ¾-inch. | 2-inch. | 4-inch. | 6-inch. | Services. |
|---|---|---|---|---|---|
| | Feet. | Feet. | Feet. | Feet. | |
| Edison Park | — | 16,589 | — | 6,522 | 83 |
| Park Ridge | — | 34,154 | — | 6,388 | 342 |
| Main Township | 1,711 | 61 | 24,033 | 14,854 | — |
| Des Palines | — | 27,792 | 6,489 | 3,591 | 347 |
| Feehanville | 376 | 522 | — | — | 4 |
| Mount Prospect | 271 | 1,811 | — | — | 16 |
| Elk Grove Township | — | — | 8,908 | — | — |
| Arlington Heights | — | 30,212 | 14,616 | — | 272 |
| Wheeling Township | — | — | 11,194 | — | 6 |
| Palatine | — | 16,741 | 5,679 | — | 158 |
| ,, Township | — | — | 38,777 | — | 1 |
| Barrington | — | 24,349 | — | — | 208 |
| ,, Township | — | — | 3,629 | — | — |
| Total | 2,358 | 152,331 | 113,325 | 31,355 | 1,437 |

## Discussion.

The PRESIDENT said the members were all aware that this highly important and most interesting paper upon what constituted a new departure within the last five years had been contributed at his special request; and he had to tender his personal thanks to Mr. Searle for the great trouble he had taken, and for the readiness with which he had complied, as also for the thoroughness of his work. The best return they could make to Mr. Searle was to give his paper a full discussion; and he was sure that if there was anything lacking in this respect it would be attributable to their want of practical acquaintance with the subject, rather than to any unwillingness on their part to discuss it. He hoped the members would do full justice to the paper, so far as their knowledge allowed them.

Mr. GEORGE HELPS (Nuneaton) said he had listened with a great deal of pleasure to the admirable paper before them. Mr. Searle had dealt so exhaustively with everything that he could imagine, in connection with the subject, that there was very little indeed left for him (Mr. Helps) to say. Perhaps his better course, therefore, would be to run through

some of his own experiences during the last three years. In the first place, he wished to express his gratitude to Mr. Shelton for all the trouble he had taken in giving him the particulars of what they were doing on the other side of the water, when the idea of adopting high pressure in this country first came into his mind. As Mr. Searle had said, this gentleman was considered to be the pioneer of high-pressure work. The text on the previous day, as he understood it, was "Uniform Pressure in Mains," so that the customers of their several undertakings could have regular pressure at their burners. The only way in which this could be brought about was by a system of high pressure such as Mr. Searle had placed before them. Not only had he given them in writing all they could require for reference, but he had illustrated his words by diagrams and the various apparatus he had brought with him; and he (Mr. Helps) could not conceive anything more calculated to benefit the industry in this country than the paper just read. The question of pressure was mentioned the preceding day; and he was afraid some of his own remarks had been misunderstood. He was endeavouring to show that uniformity of pressure was most desirable. They knew that the pressure varied from the works' governors throughout the district; the variation depending on the number of governors there were. When they had high pressure, they always had a surplus of pressure in the mains, and they had to govern it down to the requirements of their customers. There was no way of doing this, that he could think of, other than by the high-pressure system. He could not quite understand how it was that in this country they had been so long in adopting the system. He did not follow the action taken with regard to it. It seemed to him a little bit extraordinary that they should expect their customers to put down costly apparatus for increasing the pressure on their own premises, when, by the expenditure of the smallest sum imaginable, it could be done at the gas company's own works. High pressure meant a small unit of light. It also meant artistic fittings; and, further, the cost of distribution was reduced by about 60 per cent. This was a thing that affected the gas company. The customer also had his installation cost reduced. Mr. Searle had drawn attention to the advantages of high pressure in some other directions. In three years' time there ought not to be any growing works without some such system of high pressure as that which had been brought to their notice. How any engineer, after hearing Mr. Searle's paper, could contemplate extending a 24-inch low-pressure main, he could not imagine. It might, perhaps, interest the members to know that at Naneaton they had now about 10 miles of high-pressure main. When he first set out to put this main down, he intended to lay five miles of 3-inch pipe; but, after putting in the first three miles, he found there was such a surplus of gas that there was no necessity to extend it any further. Now they had about five miles of ½-inch main supplying the lamps on the road and houses. With regard to the difference in the illuminating power of the gas, Mr. Searle had pointed out that this was a very small matter indeed. He did not go in for testing with the photometer, but preferred to use his own eyesight; for he thought there was nothing like one's own eyes. When a man saw a thing with his own eyes, he could act upon what he saw; but when he saw with other people's eyes, it was difficult to understand what they conveyed to them. He had by his own eye found that flat-flame burners gave a better light with high-pressure than with low-pressure gas.

Mr. W. R. Herring (Edinburgh) congratulated the author of the paper on the excellent topic he had brought before the meeting. He thought all were agreed that their American *confrères* had earned the laurels with regard to high-pressure distribution. It was not so much that in this country they were altogether unconscious of its advantages, as that most of them—probably all, except the last speaker—were required to judge of the illuminating power of their gas by the photometer, and not by their eyes. He did not say that their eyes were not good judges, but there was a difficulty in persuading the public that they saw aright. For this reason, the subject had not received the attention in this country that it would otherwise have had. There were one or two points in the paper which appealed to him; one being with reference to leading a high-pressure main into a district in which at present the supply was short. To some extent, but on a very crude scale, this had been done in the Edinburgh district, where they had a high-pressure main encircling the city, because it was impossible to lay it through the town. The larger main which had been put down was only intended to carry a pressure of 5 lbs. They could not get away from the fact that they were tied up by the question of flame luminosity. The loss of 10 or 12 per cent. would be a serious thing so long as they were controlled by the visible flame illuminating power. It seemed to him that they might, by this system, couple up out-districts which they did not at present supply. They might say to the consumer in an outlying district: "If we come to you with gas, you must not test it with photometric apparatus; we will give you the best gas we can." Then by laying a ½-inch pipe they could supply a large number of consumers who were at present out of their reach.

Mr. E. Allen (Liverpool) said the system the author had brought before them was an important contribution to the problem of how to get their gas through crowded streets. As they all knew, in large cities with electric cables, telephone wires, water-pipes, drains, &c., there was the greatest difficulty at times in doing this. The fact that a 2-inch wrought-iron pipe instead of a 24-inch cast-iron low-pressure main would get over the difficulty, appealed to him strongly. In towns where there was more than one gas-works, it was found necessary, or at all events desirable, to convey gas from one works to another; and the use of the high-pressure system would be most valuable in attaining this end. After hearing the paper, he should go away with a very much clearer mind on the matter, and would be disposed, when the opportunity served, to make the experiment. He wished to join with the other speakers in their hearty appreciation of Mr. Searle's paper.

Mr. F. W. Cross (Lea Bridge) said he gathered that Mr. Searle had a pipe length of 68 miles, and a fall of 11 per cent. in illuminating power. The drop in the illuminating power of water gas and oil gas was greater than that of coal gas. He would like to know the quality of the oil gas referred to by the author, and whether it was the same as that made in England, because in this country they emphasized the fact of the oil gas or water gas being a carrier of illuminating power; whereas Mr. Searle said it dropped at a greater rate than coal gas. Of course, this might be due to the pressure; but the illuminating power of oil gas was looked upon as a fixed quantity more than that of coal gas. The size of the main given by Mr. Searle was very small considering its great length; and therefore he should like to ask what effect friction had upon the illuminating power of the gas. It appeared to him that the question of friction was a very great factor. Listening to the paper and the statement of the quantity of gas sent through a small pipe, one might be led away from the sublime to the ridiculous—viz., from a 24-inch to a 2-inch main—and then find he was on the wrong lines. If, as in England, it was necessary to use the high pressure for joining up outside districts, was it not desirable that this size of pipe should be exceeded, so that too much illuminating power was not lost? One other question he wished to ask Mr. Searle was as to the effect of condensation. He gathered that in the United States the weather was of a more trying nature than in England in the winter time, and that we were not subject to such great changes as they were in America. He would particularly ask Mr. Searle what was the condition of the condensation during the heavy winter weather as compared with the normal temperature to be expected in England.

Mr. S. Meunier (Stockport) said he should like to give a little explanation of the system inaugurated some two years ago in his town. At that time it became an absolute necessity to increase the supply to one of the out-districts five miles away; and knowing that Mr. Helps had been obtaining information from America with regard to the high-pressure system, and had also been working on the matter, he had a consultation with him. As the result, he came to the conclusion that, instead of carrying out the ordinary extension of a large main from headquarters, it would suit him a great deal better to put down a high-pressure feeding-main. This was carried out by the aid of Mannesmann 4-inch tube for 2½ miles, reduced to a 3-inch feeding-pipe through a Crawford regulator into a 9-inch distribution main. First of all they had only to compress practically to about 4 lbs. or 5 lbs. But as they went through the winter, and found the consumption jumping up, they had to get up to from 7½ lbs. to 10 lbs.; and he fully anticipated that they would have to go as high as 25 lbs.—at any rate, they were prepared for the contingency. The advantages of the system adopted had been very great. They had met with a few difficulties, which might have

been avoided if he had heard Mr. Searle's paper earlier. At the same time, this system of feeding an isolated district was a very useful one, was very economical, and no doubt would in future be largely adopted; in fact, he failed to see how it could really be improved upon. Mr. Allen had referred to the difficulty of laying a main through the centre of a town. Where the main supply works were in the midst of a town, the streets of which were filled up with electric cables, tramway feeders, water-pipes, drains, &c., it was absolutely impossible to lay a 24-inch main; but by adopting the method of laying a comparatively small pipe, which could be done very rapidly, and feeding through regulators, a tremendous amount of expense could be saved. It appeared to him that the system in question might be utilized for giving their customers in hilly districts a more even supply. By regulating the feeding through a governor, they would be able to keep up a uniform pressure, no matter whether the district were high or low. This was the more useful in a town like Stockport, where they had to go over the brow of a hill to supply on the far side a level which was the same as that of the works. It was a matter of impossibility to lay a circular main. There were rivers in between, and districts which they could not cut across. He thought that, by proper graduation, and by putting in high-pressure feeders, a great many of their present difficulties would be overcome.

Mr. T. Canning (Newport, Mon.) remarked that the paper was of great interest to everyone, whether or not he went in for the high-pressure system. He had very recently introduced this system for the purpose of supplying gas to a district where the pressure had become too weak. The town of Newport was divided into two parts by the navigable River Usk. Up to a few years ago, the western side was the principal part of the town; but the eastern side had shown enormous recent development, and what they had done to increase the supply was this: In the first place, he called upon Mr. Meunier for the purpose of seeing his system at Stockport, and had obtained from him a considerable amount of valuable information. First of all, at Newport he put down a compressor, the invention of Mr. Hodson. Externally it looked something like a gas-exhauster; but it differed from it internally. Supported on bearings at either end there was a steel shaft, which was used as the driving power instead of the drum. On the shaft there was a block keyed on, and this block was cast in one with the blade. The driving power was obtained in that way. He put in a 5-inch Mannesmann tube. He might be asked why he put in a 5-inch tube. He thought that, at all events, if nothing came of the high-pressure system, he would have laid a main which would be useful for carrying gas under low pressure. The governor used was a Reynolds, which he need not refer to more particularly, as it was described in the paper. He had utilized a waste place where three roads met, which was very convenient for his purpose; and there he constructed a cellar in which he had the governor. He had also taken the precaution to have an electric alarm to give a signal if anything went wrong; and, further, there was telephonic communication between the cellar and the compressor. He put in the governors in duplicate. The maker of them in America was very disinclined to permit him to have a second governor, because he felt that the fact that he ordered a duplicate one was a reflection on his system; but, in the end, he allowed him to have one, as a concession, he said, to English prejudices. He (Mr. Canning) had been able to supply the peak-load up to 30,000 cubic feet per hour additional to what he did formerly; and it was done with an expenditure of gas at the rate of 5·2 cubic feet per 1000 cubic feet. The higher they went, the less would be the cost. He was in what might be called an experimental stage. The governor had acted exceedingly well up to now; and the compressor had worked with remarkable smoothness. He had tested the illuminating power of the gas with his eye, to see whether there was any fall in it; but this test was not of much value. Of course, there must be some little drop in the illuminating power; but he had had no complaints in the district. It did not appear to be of such a character as to make it felt by anybody. He had not yet gone out a distance of eight miles; but perhaps when he did, there might be something appreciable in the way of drop to be noticed. There would be the presence of oil, which would show that something had been taken out of the quality of the gas. The paper under discussion was so exceedingly clear, that it was difficult to find anything that wanted elucidating. He had used Mannesmann tubes, which he considered were very good pipes indeed. He was surprised to hear that cast-iron pipes had been employed, as he should have thought steel pipes would be the best under all the circumstances for high-pressure gas. Having regard to the lack of homogeneity in castings, as well as for other reasons, he should not like to attempt to send high-pressure gas through anything less than a wrought-iron or a steel main. In conclusion, he wished to highly compliment Mr. Searle on his admirable paper.

Mr. A. W. Onslow (Woolwich Arsenal) said the subject before the meeting was an interesting one to him, because it opened up the possibility of increased consumption of gas. He had for some years dabbled in high-pressure gas, up to 5 lbs. to the square inch. His earliest experience of a gas-works was when they had to "dodge" the consumer to avoid his sarcastic remarks. Now the pressure was increasing because a use was being found for gas under pressure. In trying to obtain high temperatures—up to about 3000° Fahr.—he had got in about an hour-and-a-half 2500° Fahr. in a muffle furnace, either for steel heating or for melting copper. At 60 inches pressure, the temperature rose very rapidly up to 650° C.; but after that it tailed-off slowly. Watching his pyrometer to see the temperature, and speeding up the pressure to 60, 70, 80, and 90 inches, he found that the temperature rose very rapidly towards the last. In shutting down, they found that it rose at once. In fact, the result was so marked that they could temper steel bars in about 35 minutes, when formerly it used to take a day with coal and coke. They were now passing through hard times, owing to the anthracite coal and the foundry coke. He hoped during the next six months to be able to give a very satisfactory result on the difference between gas under high pressure and anthracite coal. At present, they were beating the anthracite coal and foundry coke. On the question of distribution, having various pressures, he should like to ask Mr. Searle as to the meter to be used. In his (the speaker's) case, he had an initial pressure into a building of 100 inches for furnace work, going down 40 or 60 inches for lighting and flat-flame burners. So that it might be taken at a constant pressure of about 100 inches initial pressure into the building. He did not attach any importance to the question of whether it should be 5, 10, 15, or 20 lbs. to the square inch, provided the pipes were bottle-tight. It was only a question of degree. What concerned him most was what to do with the gas when they got it into the pipes. Having the greater part of it under pressure, his attention was drawn to using it to the best advantage; and he was surprised at the result. He was now making an effort to do in eight hours what certain furnaces formerly did in 24 hours. If he succeeded, it would administer a nasty knock to other systems of heating. The whole of Mr. Searle's paper was so interesting that one scarcely knew how to criticize it. As to the method of laying the pipes, in his own case he used wrought-iron, not cast-iron, ones, because the question of ground vibration had to be considered. Having sometimes a concentrated load of 160 tons passing over the pipes, which were laid close to the surface, it would be a serious thing to have any which might fracture. Up to the present time he had had no difficulty with wrought-iron pipes.

Mr. A. Wilson (Glasgow) said there was one point on which he should like a little more information—viz., as to the cost of pumping. Perhaps Mr. Searle might give a few particulars on this subject, as some set-off for the capital expenditure.

Mr. S. Y. Shoubridge (Lower Sydenham) asked if there had been any difficulty with naphthalene in the small pipes. One could imagine that, if there were much naphthalene, the small pipes would prove a great hindrance.

Mr. Douglas H. Helps (Reading) asked if Mr. Searle had experienced any breakdown with his boosting plant, and, if so, whether he could bring his reserve apparatus into use before the breakdown caused inconvenience to the consumers. In his paper, he stated that beyond the governor all the supply was treated as though a low-pressure gas system were in use. On this, he should like to ask at what pressure Mr. Searle supplied the burners inside the building, and also whether there was any difficulty in connection with the meters with the gas at high pressure.

Mr. T. Glover (Norwich) asked whether the cost of the governor was treated as part of the service, as in this country it was usual to charge for governors fixed on the outlet of the meter. He took it that the governor would be considered as part of the service, and, under an intelligent

manager, would not be charged for. He thought it would be appropriate to place on record the special thanks of the Institution for the literature which was to be added to the library; and he would also suggest that, if necessary, the Institution should bear the cost of the exhibits Mr. Searle had brought with him, and that they should be kept at the head-quarters of the Institution.

Mr. T. J. Reid (Ballina) said what he specially wanted to ask the author of the paper was whether the high-pressure distribution system could be applied to small towns such as they had in Ireland. The characteristic town in Ireland was one with from 4000 to 5000 inhabitants, a make of gas of 3 to 10 millions, and five miles of mains. Would it be possible or proper in such a town to manufacture gas only using a relief holder, and sending it out at high pressure? He believed this had been done. Would Mr. Searle advise the manager or the directors of small gas-works such as he had described, where the mains were about to be relaid, to adopt the high-pressure system in its entirety? He believed this had been done in the United States by the North Shore Gas Company.

Mr. Searle, in reply, said he first wished to point out that anyone who was sufficiently interested in the subject could obtain, by visiting their head-quarters, everything that had ever been written, said, or done in the way of high-pressure distribution in America. The literature was complete. His friends had been very good to him; and he had had it thoroughly boiled down and everything that did not relate to high pressure cut out. If they started with Mr. Shelton's paper, and followed it right through, they could not make a mistake. With regard to the effect of condensation, if they began in a compressor where the heat was radiated they had a temperature *minus* the water of dehydration. There would be a loss of the fixed illuminants, which came down under pressure; but they would be absorbed again, because the gas would pick up the carrier. At certain fixed pressures, there were fixed saturation-points. The effect of the condensation would be practically *nil*, because they had winter in the compressor so to speak. In this they compressed at high pressure, the temperature rose, and the water of condensation dropped out. If any of it, due to the velocity, was carried forward, it would impinge on the separator that Mr. Rice had found necessary, and drop as liquid within a mile of the works. For the loss in candle power they had the gain by hydration. With low-pressure distribution, it was 5 per cent.; and there had to be added to this 5½ per cent. extra illuminating power. The additional expense was not serious. With regard to possible errors in laying large mains for a small delivery, of course there had been more mistakes made with regard to high pressure than there should have been. Taking a specific gravity of ·5 for two miles, and assuming the gas to run into a factory with a 1-inch pipe, this would give a delivery over the 1-inch pipe of 1090 cubic feet per hour. With the high-pressure distribution system, they could start at the end with the large feeder—assuming the works were at the water side and the village to be supplied was a mile inland—and run a 2-inch pipe out to the district; and, out of 8760 hours in the year, they had to send the supply for only 760 hours. Could they imagine a 12-inch main lying idle for 8000 hours in the year, and then having to charge up to the cost of that particular load the interest on the main? In such a case, it would be much better to refuse the business. In laying the high-pressure system, when connecting up a large number of low-pressure systems, it was not always necessary to follow the course of the road. They might take a route through a farm; and if a man built a house on the line of route, they could put a 2-inch pipe right round his building, and then go on again. It would afford him (Mr. Searle) great pleasure to present to the Institution the samples he had brought with him; and, as they were an essential part of his paper, he did not see there was any reason why anybody should be remunerated for them. He agreed with the suggestion that steel pipes should be used. There was a great deal of nerve wanted to lay 50 miles of cast-iron pipes, because they knew how easily such pipes became fractured. With regard to the effect on the meters, he presumed that the dry gas going into a meter would cause some additional degree of wear on the diaphragms, because at the lower pressures the gas had a particular affinity as it expanded to grab something; and it might easily grab some of the oil in the diaphragm—either the neat's-foot oil or whatever other oil might be considered best to employ. The high-pressure system, when used along the highways for lighting the street-lamps, gave the advantage of intensified lighting; and this was a good source of income. Business could be obtained in this way that could not be dreamt of with the low-pressure system. With regard to the cost of pumping, they might assume an appreciation on the exhauster of 12½ per cent.; but this would probably be five times too much. The assumption had been made for all steam loss and all radiation loss, and that steam would be used as a compressing agent; and it was reckoned that 2 c. per 1000 cubic feet would cover every possibility. With regard to the fear of breakdowns, and having to bring the reserve plant into use, a large number of miles would clearly act as a holder. In the case of the North-Western Gaslight and Coke Company (which was really the North Shore Company), the supply would hold out for about half-an-hour; and there was no reason why, with a suitable duplicate compressor, it should not be brought into use in five minutes. The governors were invariably looked upon as part of the service. The compressor supply at the burner was approximately 2½ inches; and it was practically uniform for the whole 24 hours. The applicability of the system to small towns was the one redeeming feature of it. Such towns could have a gas supply that could not be dreamt of under the low-pressure system. He should not hesitate to couple up five or six towns, covering a distance of two, three, or four miles, radiating as a spider's web, with 1½-inch pipes. He referred to towns with a population of 2500 or 3000. They could run miles of ¾-inch mains in a town. It was marvellous how uniform was the consumption of small cities, and how little peak one got in small places. If they had a full consumption in a town where the people were in the habit of going to bed early, it was very even, and there was no peak. It was perfectly feasible to take gas direct from a retort, with compensating apparatus, into small gas-works, and use steel tanks. He should say it would be preferable to save their money on the main system, and put it into the tanks. They were in a difficulty if they had a breakdown, whether it was at the works or in any building. He should certainly adopt the high-pressure system for a small plant. The plant when finished for a town of 7000 people, with a maximum capacity of 100,000 cubic feet, was not much larger than a watch charm; and it could be completed for well within $18,000.

The President said they would all agree with him that their thanks were specially due to Mr. Searle for his contribution, and also for the abundance of literature and specimens with which he had so kindly furnished them.

## THE TESTING AND HYGIENIC EFFICIENCY OF GAS-FIRES.

**By Jno. H. BREARLEY, of Longwood.**

It is a singular fact that, though strenuous efforts have been made to rivet the attention of the public upon the subject of smoke prevention, there is in the "Transactions" of the Institution of Gas Engineers a notable dearth of papers bearing upon the aspect of the question which is of chief concern to its members—viz., the popularization of heating by gas. The Coal Smoke Abatement Society have done much useful work; but it would appear that greater attention must be paid to the subject by gas engineers if gas as a heating agent is to make the advance which its intrinsic merits deserve. The use of gas as a domestic fuel is in some instances developing in a gratifying manner. For example, in his paper read before the Coal Smoke Abatement Society, Sir George Livesey referred to a canvass of 997 houses in certain streets supplied by the South Metropolitan Gas Company, and stated that of this number 379 consumers used 770 gas-fires. As the subject stands, this proportion must be regarded as eminently satisfactory; but at present there is nothing like such a ratio generally, or there would be at this moment nearly 4 million gas-fires in use among the 5,064,075 consumers tabulated in the last Board of Trade returns.

As Sir George Livesey said, no householder will give up his coal-fire simply to prevent a smoky atmosphere. He must be put in possession of more cogent reasons before he will adopt gas-heating. It is to be feared that, not only among the public, but also among gas engineers, the feeling is far too prevalent that coal has a decided advantage not only in cost, but also from a hygienic standpoint; and this has begotten an apathetic treatment of the subject which has

done more to retard progress than has any shortcomings in gas-heating intelligently applied. If this apathy can be removed, the branch of gas supply for heating purposes will make great headway; for it will lead first to the evolution of satisfactory methods of testing, and afterwards to their general adoption of efficient apparatus. The result will be the gradual elimination of fires defective in construction, extravagant in gas consumption, or unhealthy in use. It was towards the close of 1902 that the writer determined, when opportunity occurred, to devote closer attention to this subject; and it was partly due to some remarks made by Professor Lewes, in a Cantor Lecture delivered before the Society of Arts, and reported in the "JOURNAL OF GAS LIGHTING" for Dec. 16, 1902. The lecturer said:

**There are many gas-stoves on the market which, both in performance and effect on atmosphere, are radically bad. Now that gas companies have taken over the sale and pushing of gas-heating apparatus, it is a duty they owe to themselves and their customers to take care that only stoves of scientific construction are supplied. Many of the worst stoves are the most ornate. No gas-fires should be sold or let out on hire that do not do a large portion of heating by radiation. A gas company which sells a flueless stove, except for passage or hall heating, should be prosecuted.**

It has always seemed remarkable to the writer that so little notice was taken of this utterance. If it may be said without irreverence, we have so often felt that if we could but touch the hem of the Professor's garment our shortcomings would quickly disappear. Yet after nearly five years we know that, if the above dictum were carried into effect, the law would be busy—the conscientious objector, the suffragette, and the motor-fiend would have to look to their laurels.

What is a stove of scientific construction? By inference, Professor Lewes answers, "One giving the greatest proportion of radiation and the products from which are not allowed to enter the room in which the gas-fire is fixed." To carry this into practical effect, gas-fires must be tested as systematically and as certainly as are coals or (more appropriately) as lighting burners are tested before being purchased on a large scale. In this phase of the subject, an account of the writer's experiences may be of interest, if not of service, to his fellow members. Let it be at once understood that there will be no attempt to compare the fires of different makers—a proceeding that cannot be too strongly deprecated in the present immature development of known methods of testing. If this paper assists in stimulating—as it certainly needs stimulating—research into this subject, it will have achieved its object. It will be observed that the fires operated upon are denoted in the tables by a distinguishing letter only.

*Testing for Radiation.*—A method commonly employed for testing radiation is to place one or more thermometers at a given distance from the gas-fire and note the rise in temperature produced. But this method is open to objection; for while the rays are heating up the bulb, currents of air moving towards the fire may be cooling it. As an improvement on thermometers pure and simple, rectangular copper vessels, which, for convenience, are termed radiation calorimeters, as illustrated in fig. 1, were used. The side facing the fire was blackened to assist absorption, and the calorimeters were filled with water—provision being made at the top for the insertion of a thermometer secured in position by a bored cork. These were placed at a distance of 2 ft. 6 in. from the fire in the positions shown, and the temperatures were observed on lighting up and six hours afterwards; care being taken before the last reading to agitate the water thoroughly, so as to get a record, as far as possible, of the average temperature. Though fairly comparable results were obtained, the method was crude, cumbersome, and open to the same objection as applies to the use of simple thermometers—viz., cold currents striking the reverse side.

Attention was then directed to the employment of the thermopile and galvanometer (figs. 2 and 3), which proved quite satisfactory. Observations were taken more quickly, and with greater relative accuracy. The thermopile used was of Ruben's linear type, with couples of fine iron and Constantan wires, and connected to one of Paul's single-pivot moving-coil galvanometers, with a scale marked in millionths of an ampere. When in use, the alternate junctions of the thermopile are exposed to the rays from the gas-fire, and an electric current passes along the wires to the galvanometer, and causes the needle of the latter to deflect proportionately to the intensity of the rays. It is well known that the intensity of radiation emitted from a point is the same at equal distances from the point; and

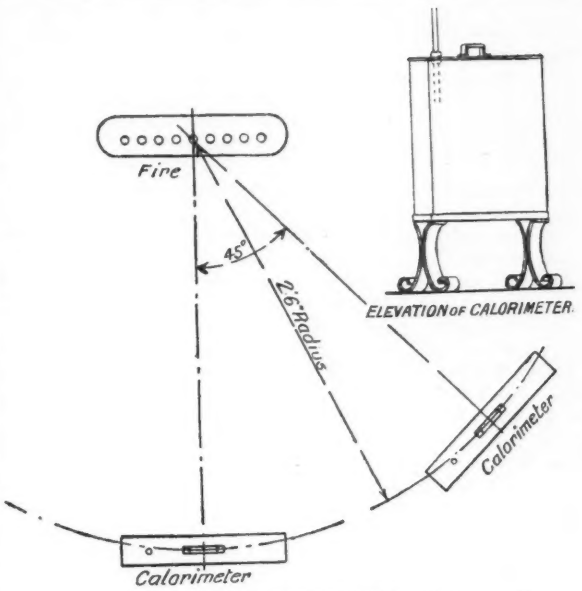
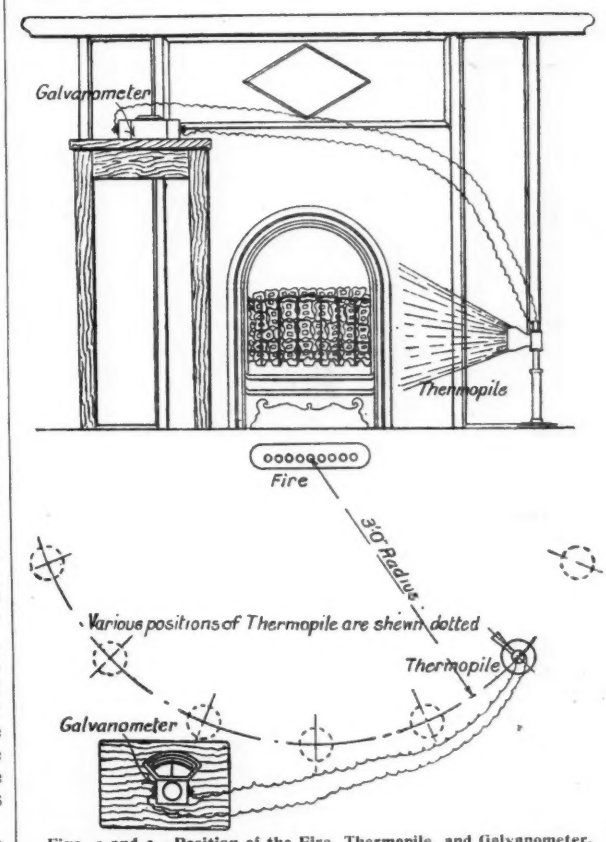



Fig. 1.—Position of Fire and Calorimeter.

at unequal distances it is inversely as the square of the distance. A reading of 36 on the galvanometer at a distance of 4 feet would, therefore, correspond with a reading of 16 in the same plane at a distance of 6 feet. Heat, too, like light, radiates from all bodies in straight lines and (unless obstructed) in all directions.




Figs. 2 and 3.—Position of the Fire, Thermopile, and Galvanometer.

When considering the flue type of gas-fire, one is chiefly concerned with the radiation which may be recorded in the half-circle described by a number of persons sitting "round" it. To make comparisons, such a half-circle radiating from the centre bunsen of each fire was marked out (fig. 3) on the floor 3 feet distant. On the line of this half-circle, in the positions indicated, seven readings were taken of each fire, after the fire had attained its normal heating condition. The distance of 3 feet was adjudged sufficiently far from the fire to ensure those tested being within the area of lines projected from the sides of the hood of the thermopile (fig. 2). In each of the seven positions at which readings

were taken, care was exercised so as to obtain the maximum vertical reading by adjustment of the thermopile. This point was invariably in the horizontal plane of the hottest part of the fire under test. The temperature of different parts of a bunsen flame varies considerably, and the distance from the floor at which the maximum reading will be obtained is influenced by (*a*) the shape of the bunsen flames, (*b*) the arrangement of the fire-clay fuel—often misnamed asbestos, and (*c*) the difference in the height from the floor to the bunsen in different types of gas-fires. Bunsen flames vary in shape according to the form of the orifice and the construction of the burner; but the shape and size is also affected by (*a*) an adjustment of the air supply (*b*) the composition of the gas, and (*c*) the pressure at which the gas is supplied. It will be seen, therefore, how necessary it is that the thermopile should be adjusted to get the best reading in each position at which observations are taken.

Having considered the instruments used, the method of testing, and the principal points to be observed, attention may now be directed to some of the results recorded in Table I.; the basis of comparison being explained in the supplementary notes thereon. In the first twelve tests the same type of fire was used. In tests Nos. 1 to 4 the fire contained neither fire-clay nor iron frets; the bunsens being lit in the shell of the stove with the fire-brick back. Tests Nos. 5 to 8 were taken with iron frets in, and Nos. 9 to 12 with fire-clay fuel. Summarizing and averaging the four tests under each condition, the following comparative radiation value is obtained:—

| Refractory Medium. | Average Reading. | Ratio. |
|---|---|---|
| Bunsens only . . . . . | 50 | 100 |
| Iron frets . . . . . | 136 | 272 |
| Fire-clay fuel . . . . . | 125 | 250 |

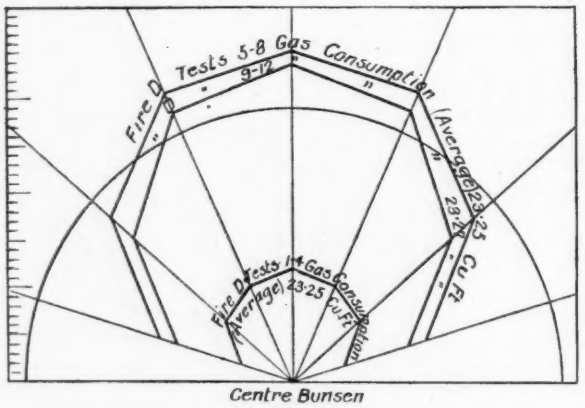

Fire D Tests 5-8 Gas Consumption (Average) 23·25 Cu. Ft.
" 9-12 " " 23·25 "
Fire D Tests 1-4 Gas Consumption (Average) 23·25 Cu. Ft.
Centre Bunsen

**Diagram 1.**

Diagram No. 1 also illustrates these results; the number of the respective tests being placed beside each curve. Here is shown, in a simple but none the less forcible way, the importance of the problem of radiation. Though the heat generated under each comparative test would be the same, we have an exemplification of the value of the media for utilizing it in the form known as radiant energy. It has always been understood that iron frets give off a greater proportion of radiation than fire-clay fuel does, though in the above tests the latter only comes about 8 per cent. below the former.* There is, in the writer's opinion, an interesting field here for research. If the public refuse to have frets, has finality been reached in fire-clay balls? And if finality has been reached in the latter, are we assured that the variety as to composition, shape, colour, &c., in common use develops the highest amount of radiation, and cannot with modification be induced to give better results than are at present obtainable?

In comparing the tests, it will be seen that the difference in efficiency between iron frets and fire-clay fuel is more marked at low pressures or short flames than at the higher pressures—a result that is probably explained by the different conductivities of the materials. At 2½ inches pressure, the difference (Nos. 8 and 12) is only 5 per cent. It may here be mentioned that the whole series of tests showed that no fire-clay fire without suitable gas and air adjustment should be fixed with a less pressure than 1½ inches, and, even with adjustment, the efficiency is much lower at 1 inch than at 1½ inches. This will be seen by a perusal of the figures recorded in tests Nos. 23 to 30.

A fire fitted with the duplex arrangement for turning out a number of outer flames was used in tests Nos. 13 to 22. There were seven bunsens, the duplex cock extinguishing four and leaving the central three alight. In tests Nos. 13 to 15, the central three only were alight; while in tests Nos. 16 to 18 the whole range of seven bunsen flames were turned down to suit the respective consumption of the previous three tests. The value of the duplex arrangement for "turning down" the supply is here strikingly demonstrated; the relative efficiency being as 133 to 100. Diagram No. 2 also illustrates this.

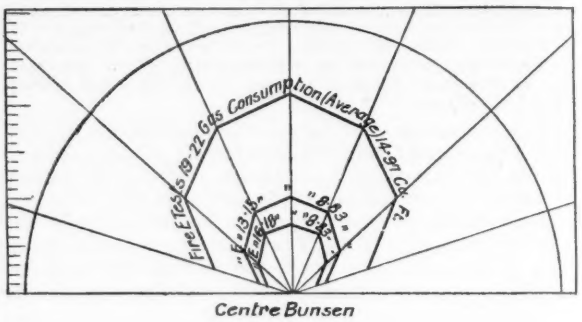



**Diagram 2.**

Tests Nos. 23 to 30 give the results recorded in comparing two slot fires which have been boomed considerably by their several makers. Tests Nos. 31 to 38 were taken with a view to seeing whether exchanging the fuel of one maker, putting it into the fire of another, and *vice versâ*, would throw any new light on the subject. But the only effect was to slightly reduce the efficiency in each case, probably through the fact that the fuel did not so accurately fit bunsens for which it was not intended. It should be here explained that the row of bunsens in "Fire G" were slightly curved; the burners of all the other fires being in a straight row. Diagram No. 3 shows that the curvature has the effect of more evenly

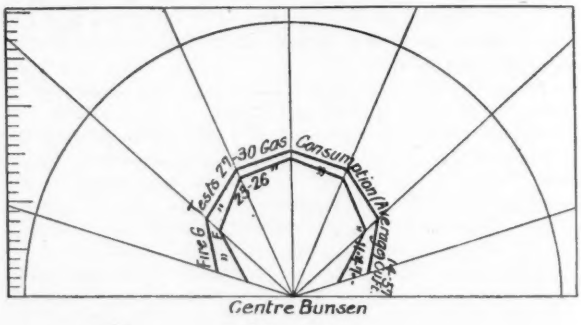



**Diagram 3.**

distributing the radiation; the readings at the sides being relatively higher than in any of the other fires.

The value of an investigation into radiation efficiency is amply illustrated in tests Nos. 39 to 54, all of one fire ("H") under various modified conditions, and set out in Diagram No. 4. Nos. 39 to 42 give the results recorded from observations of the fire as it was delivered from the makers. It

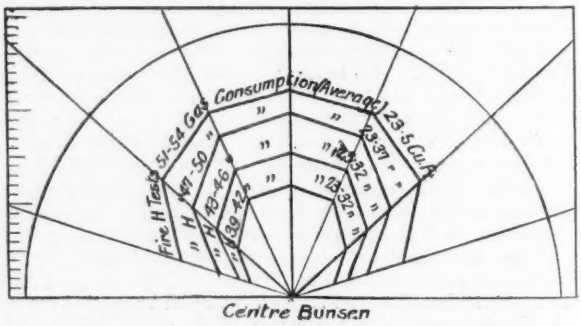



**Diagram 4.**

* In supplementary notes to the fifth edition of his excellent work on "Coal Gas as a Fuel," the late Mr. Thos. Fletcher gave particulars of comparative tests of a similar nature, in which the ball-fire came 26 per cent. below the iron spray fire. He used a black bulb thermometer *in vacuo*, placed in one position only, 3 feet from the fire.

had an average depth of fuel (front to back) of about 5½ inches, behind which was placed a series of hollow tubes; the idea being that cold air would pass up these, and before issuing into the room would be greatly raised in temperature. Such undoubtedly was the case; for in the subsequent tests for heated air, this fire gave a very high duty. But it was at the expense of radiation, and this to an alarming extent. The radiant duty was but 44, or not more than 40 per cent. of what must be considered a satisfactory figure on the basis of comparison taken. It may be noted, too, that this efficiency was less than when the bunsens only were tested in tests Nos. 1 to 4, in which the lining of the stove was a solid fire-clay brick.

The hollow tubes were taken out, and replaced with a solid 3-inch tile—a depth of 5 inches of fuel remaining in front. The duty was raised to 60 (tests Nos. 43 to 46). The thickness of the fire-clay tile was raised to 4½ inches—*i.e.*, the depth of fuel reduced to 3½ inches—and the duty increased to 75 (tests Nos. 47 to 50). Again, the depth of fuel was reduced by putting in another tile, 1½ inches thick, leaving 2 inches of fuel. A much more cheerful fire was obtained, and the duty was raised to 91, which, considering the starting point of 43, was a vast improvement. An improved type of the same fire was subsequently received from the makers, in which the depth of fuel was only 3 inches. The duty of this was 81 (tests Nos. 55 to 58), which is still appreciably less than the old type with the solid tile.

From these tests, two important conclusions are arrived at: (*a*) That air heating tubes or chambers at the back of a fire reduce radiation; and (*b*) that a thin body of fue is essential to a high radiation efficiency. "Fire J" contained a row of five fire-clay tubes; the flames passing up the inside. In plotting the curves in Diagrams Nos. 1 to 4, correction was made for calorific value.

In his excellent lecture delivered before the Institution of Gas Engineers in 1905, on "The Temperature of Flames," Professor Smithells said that if we are burning gas at a fixed rate, the smaller volume into which we can get the flame the higher must be the temperature. It does not follow, however, as has been assumed by others, that a greater duty may be obtained from gas-fires by the application of high pressure, which has the effect indicated by Professor Smithells, of raising the flame temperature. There will be a greater intensity of radiation, but only from a smaller area; and the gain in intensity may be lost by the smaller area of refractory material heated. This can be demonstrated by taking a gas-fire fitted with gas and air adjustment, and highly oxidizing the flame. The duty indicated by the thermopile and galvanometer is practically the same in both cases. When the flame comes to be highly oxidized, it does not fit the fuel as well as when burning under normal conditions; and further research is needed into the effect of compressing gas or air, or both, with suitably devised fuel From the same table, which was given by Professor

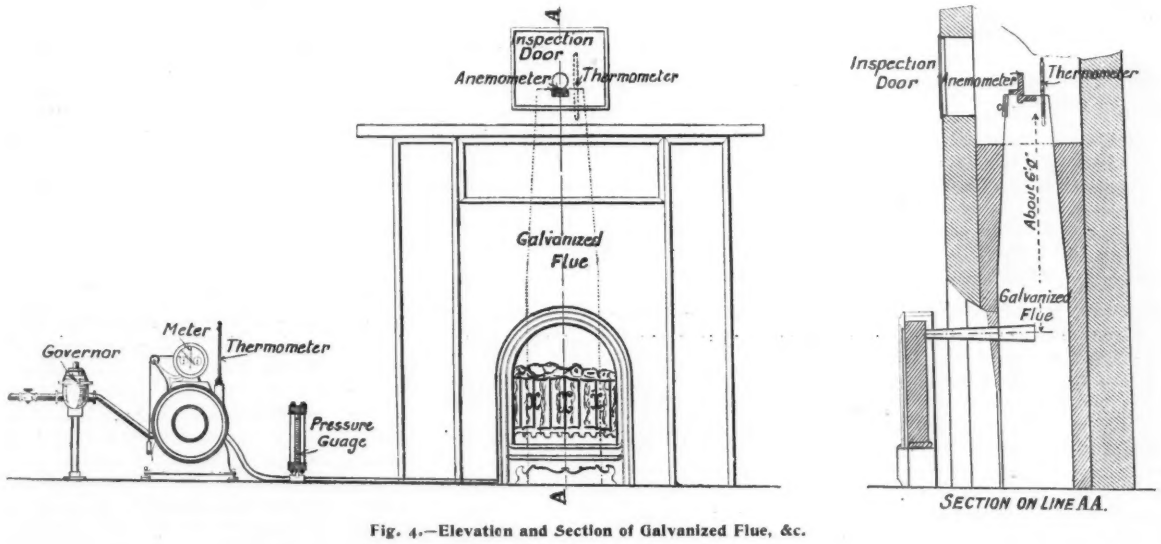



Fig. 4.—Elevation and Section of Galvanized Flue, &c.

Smithells in his lecture, it will be seen that the maximum temperature of a flame with insufficient air was but 1712° C., as against 1871° C. when fully aerated—a potent reason why the air supply to all gas-fires should be under perfect control. Many makers now supply with fires of their manufacture gas and air adjusters; and as these give independence of pressures (within certain limits) and calorific value, the fixing of a separate governor is dispensed with.

*Testing for Heat Carried away in the Waste Products (Flue Heat).*—So far as the writer is aware, no satisfactory method of arriving at the amount of heat carried away with the waste products has been published. When he first turned attention to this portion of the subject, the most plausible way appeared to be to take the speed and temperature of such gases, and from these factors calculate the number of thermal units passing away. To carry this method into accurate effect, the temperature should be taken immediately the products leave the fire; but as to measuring speed, no anemometer will for very long stand such a temperature as that at which the products would have to be measured.

To overcome this difficulty, the products were discharged from the stove flue by an extension piece into a larger galvanized tube drawing away also air from the room; the latter acting as a diluent to the hot gases. At a point about 6 feet from the stove flue outlet (fig. 4), a thermometer was fixed, and when a constant (or as near thereat as possible) had been reached, the reading was recorded. At the same point, the speed was taken by an anemometer without injuriously affecting it. After a series of observations, it was concluded that this method, though affording an approximate comparison, was not sufficiently accurate, because of (*a*) the varying temperature of the diluting air, (*b*) the imperfect mixing of the products with the air, and (*c*) conduction through the sides of the galvanized flue. It will be remembered that, in the tests conducted by the Smoke Abatement Commission, the temperature of the waste products was taken at a point 6 feet from the outlet of a 9-inch diameter flue pipe, 68 feet long, and the speed calculated by a method which they devised and described as the "smoke test." On Dec. 8 last, the author ventured to criticize these methods in the "Gas World." It should be said, however, that they probably adopted the best methods they could under the circumstances in which the tests were taken.

Attention was subsequently turned to abstracting the heat from the products, and calculating the quantity of thermal units passing, in the same way as the calorific value of ordinary coal gas is measured. To this end a Wilson's circulating water-heater was adapted (fig. 5); and the results obtained amply justified the experiment. When tested against a Junkers calorimeter, the circulator gave an efficiency of 90 per cent. For the purpose of this test, a specially adapted double ring-burner consuming 30 cubic feet of gas per hour was used. Though the waste products when passed through the circulator were not brought down to the initial temperature, it was possible by calculation to estimate the units remaining in the products at the outlet. The highest heat registered in any instance at the inlet to the calorimeter was 737° Fahr.; and there was no difficulty in reducing even this to the moderate figure of 122° Fahr. at the outlet.

Consideration was given to three methods of ascertaining

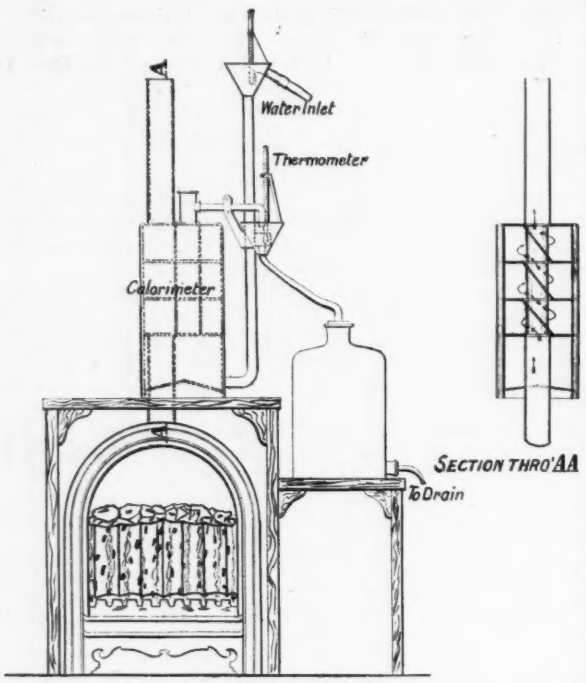



Fig. 5.—Arrangement of Calorimeter, &c.

the units of heat remaining in the gases after passing through the calorimeter—

(*a*) To measure speed by an anemometer, and temperature by a thermometer.
(*b*) To analyze products for carbonic acid and calculate therefrom cubic feet passing per hour.
(*c*) To calculate cubic feet passing from the reduction in the temperature effected by the calorimeter, and the units of heat recovered thereby.

It was concluded, after a number of tests, that the method "C" was most reliable; the supplementary notes to Table No. 2, "Estimation of Flue Heat,"* giving the method of calculation. The Committee of the Institution of Civil Engineers which recently carried through an investigation into the "Efficiency of Internal Combustion Engines" had a similar problem to contend with in estimating the heat carried away by the exhaust gases from engines. The calculation in the gas-fire tests is in the same way complicated by the fact that the waste products are not dry gases but fully saturated with steam. The dew-point varies at different temperatures, and to avoid a detailed calculation in each test, a curve (Diagram No. 5) was prepared, from which the heat contents of 1 lb. of saturated products could be read off with sufficient accuracy for the purpose aimed at.

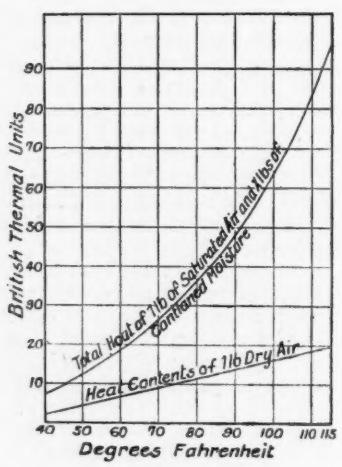



Diagram 5.

By the method adopted, it will be seen that the units of heat left in the waste gases as measured varied enormously—viz., from − 30 to 1754 in number, and from − 0·7 per cent. to 10·4 per cent. (Table No. 2, col. 17) of the total units generated. This was due to the great difference in the temperatures at which the products emerged in the various tests. The capacity of such products for carrying away heat increases at a much greater rate than does their increase in temperature, which will be clearly seen from Diagram No. 5. While at 40° Fahr. 1 lb. of the products will carry away 7·4 B.Th.U. of heat, the same weight of products will carry away 26·2 units at 70° Fahr., and 63·5 units at 100° Fahr.

It will be seen that in tests Nos. 43 to 48 the calorimeter actually reduced the temperature of the waste products below the room temperature; and to maintain comparison the excess heat abstracted was calculated for, and *minus* signs were used in cols. 16 and 17. The recorded results show that, in carrying out tests of this nature, the operators should aim at getting the outlet temperatures low, so that as much of the work as possible is done by experiment, and as little as need be by calculation, even though the latter is based on the actual work of the former.

A larger calorimeter was subsequently employed, to which reference is made later. The results obtained in each pair of tests show sufficiently uniform results to commend the method as a great advance upon any tests carried out in the actual flues of buildings—*i.e.*, when the comparative merits of various fires are under consideration. As a matter of fact, the heat loss in a domestic chimney varies a great deal according to the method in which the fire is connected. The chimney should be allowed to draw a large portion of the air from the room without an excessive vacuum in the stove flue pipe, as is the case when the whole of the air which leaves the room is drawn through the stove itself. For this reason those stoves which are provided with ventilating outlets, in addition to the flue pipe, are to be commended. Where such devices are not used, the whole of the chimney opening should never be blocked up. It is often assumed that the heating efficiency of a gas-fire stove is increased by doing this, whereas the reverse is the case. Some experiments upon this point were made with one fire under three conditions—viz., (1) Placed 1 foot from the chimney and the products conveyed to the latter with a galvanized tube of the same bore as the stove flue pipe, the chimney remaining open. (2) Placed close up to the coal-range with a shorter extension flue pipe. (3) Placed close up to the coal range, with the space around the stove flue pipe entirely blocked up with asbestos sheeting.

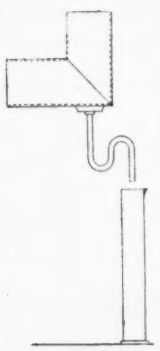


Fig. 6.—Galvanized Bend with Automatic Syphon.

A series of readings on the galvanometer, with the thermopile placed 3 feet from the centre bunsen, gave the following average results: (1) 25; (2) 22½; (3) 21½. Observations were made at the top of the galvanized flue (fig. 4) of the air carried away per hour, and gave: (1) 2450 cubic feet; (2) 3430 cubic feet; (3) 3530 cubic feet.

Samples of air taken immediately in front of the canopy, but about 6 inches above its lower edge, gave the following differences in the percentage of carbonic acid, indicating that the products did not all go through the stove flue pipe:—

| | (1) Per Cent. | (2) Per Cent. | (3) Per Cent. |
|---|---|---|---|
| Air supply to fire | 0·093 | 0·099 | 0·091 |
| Sample at canopy | 0·156 | 0·154 | 0·141 |
| Increase | 0·063 | 0·055 | 0·050 |

As the vacuum in the gas-fire flue pipe increased, the radiation duty decreased between the first and third positions no less than 14 per cent. In position 3, carbonic acid bye-passed into the room, notwithstanding that 3530 cubic feet of air per hour passed through the stove flue pipe. It has to be concluded, therefore, that an excessive vacuum reduces the radiant efficiency, and that an excessive vacuum is not synonymous with intrinsic hygienic efficiency. Hygienic conditions are not necessarily unsatisfactory. This is not true even when speaking of the average gas-fire stove as now constructed, if it is fixed with intelligence, and properly proportioned. Although products bye-pass into the room, the stove rectifies its own defect by creating such a current up the chimney as to change the atmosphere sufficiently often to keep the air of the room satisfactory. Ventilation can hardly be carried out economically in this way. The proper course for the carbonic acid (as representing the products) to take is out at the flue-pipe; and less heat should

* The expression "flue heat" is used in preference to "waste heat" because the heat really performs the valuable function of ventilation.

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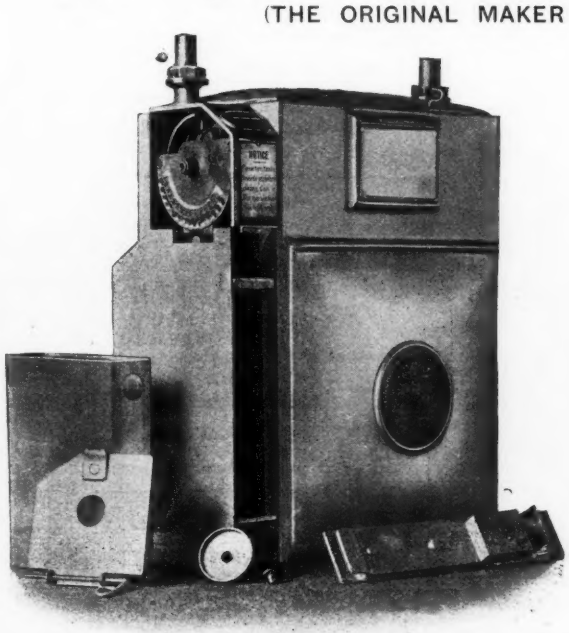

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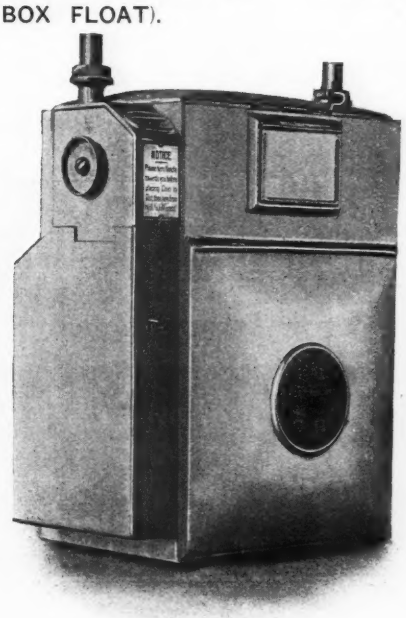

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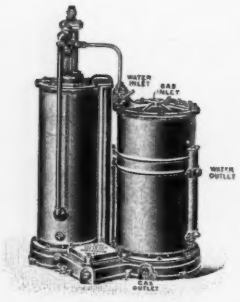

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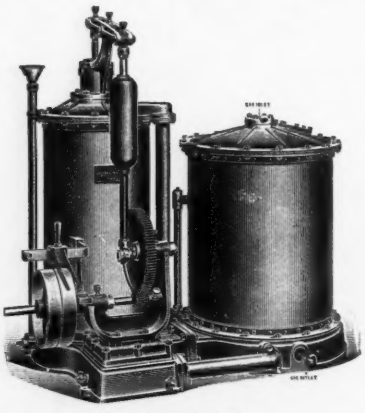

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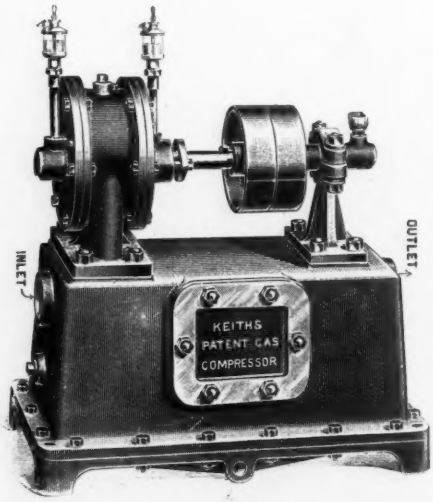


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be needed to satisfactorily remove it in this way than after it has been dissipated in the room. This assumes, of course, the chimney flue as the only agent of ventilation.

In the foregoing results, attention may be drawn to the important difference which can be made by a slight deviation in the position of the stove in relation to the chimney flue, and also by providing or preventing ventilation independent of the stove flue pipe—points on which the data available for gas-fitters is yet all too meagre.

*Testing for Heat of Convection.*—Having obtained a satisfactory method of comparing radiation efficiency, and an improved method of measuring the heat contained in the waste products, there still remained the problem of comparing gas-fires in the power of imparting heat to the air circulating in and around them. After considerable reflection, a hood was constructed (fig. 7) of wood, $\frac{3}{4}$ inch thick, with joints carefully made tight, and the inside lined with $\frac{1}{8}$-inch asbestos sheets. The height (about 9 feet) was determined by the distance from the fire at which it was safe to take temperatures without the latter being influenced by direct radiant heat. Experiments made with a hood 3 feet shorter showed that the temperature of the outflowing air varied a good deal at different points in the outlet area, a defect the additional length satisfactorily overcame.

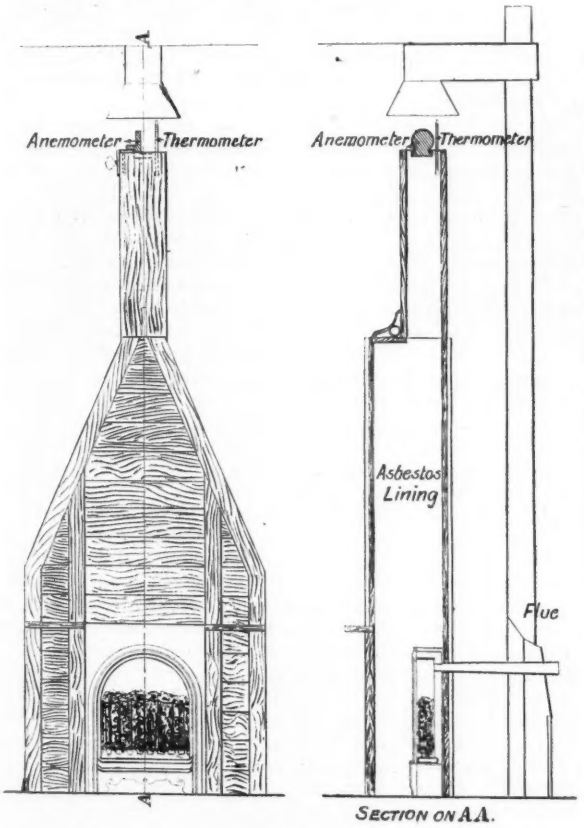



Fig. 7.—Elevation and Section of Fire and Hood.

When the gas-fire under test was in position, the flue pipe passed through a 6-inch slot at the back of the hood; the remaining space being made up with asbestos. The opening at the front, as shown, allowed nearly the whole of the heat which took the form known as radiation to pass unobstructed into the room. A small proportion of the radiation —viz., that which came from the sides and canopy of the fires—would impinge on the inner lining of the hood, and as the air passed over the latter, be converted into convected heat—being included as such in the results which are subsequently given.

Diagrams Nos. 1 to 4 show that, immediately the thermopile is moved out of the direct rays of the refractory material, a rapid diminution in the galvanometer reading results. In Diagram No. 1, two of the curves are continued by dotted lines to show the proportional reading when the thermopile was placed in a line with the fire under the same conditions as the full-line curve was obtained. The radiation reading vertically, or horizontally at the sides of a gas-fire, rarely exceeds 5 per cent. of a reading taken horizontally, in front, and at the same distance—*i.e.*, assuming the bunsens to be in a straight row. When the thermopile was placed at the output of the hood, in no case was a deflection of half a point on the galvanometer obtained. It was therefore concluded that such radiation as came from the sides and top of a gas-fire stove had changed to convected heat.

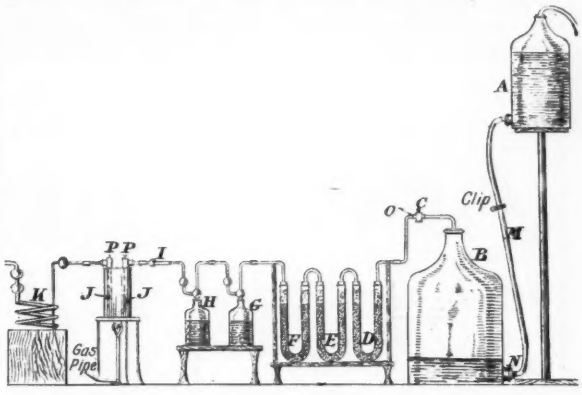



Fig. 8.—Carbon Monoxide Testing Apparatus.

After connecting and lighting each fire, it was allowed to reach a normal heating point, as indicated by the anemometer and thermometer placed at the outlet of the hood. The readings then obtained, together with supplementary notes, are given in Table No. 3. Column 13 gives, in percentages of the total heat generated, the amounts recorded by the method here described. One has to deplore that in every case a considerable portion of the products joined the stream of air up the hood; but it must not be concluded that there was a "pull" on the fire, except by the stove-flue, which was extended by galvanized piping to the bottom of the chimney. The results obtained with the testing hood taken in conjunction with the analyses of air samples taken at the canopy of one of the fires, and previously referred to, point to the conclusion that either the hoods or canopies of gas-fires are wrong in design or the flue outlet is too small, or both. There may be gas-fires that do not merit this criticism; but they did not come within the sphere of these experiments. Those tested were representative of most of the types in use.

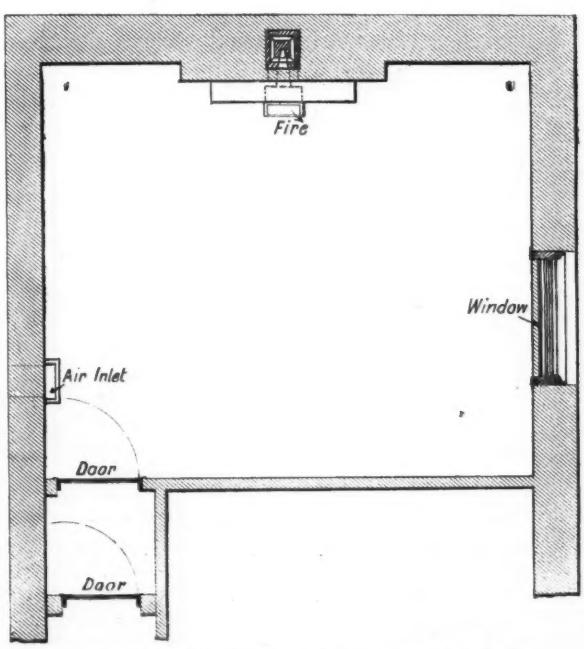



Fig. 9.—Plan of Testing Room (Capacity 2030 Cubic Feet).

Each fire was tested for heated air at three pressures; and Table No. 4 gives the average results obtained. These are abstracted from Table No. 3, and, in addition, particulars are given of the area of flue-pipes and hoods, with the proportion in square inches which these bear to the gas

consumed. Table 4 indicates an enormous variation in results. The great difference which took place when "Fire H" was changed from a backing of air tubes to one of solid brick has already been referred to so far as concerns its radiant properties, an increase from 43 to 91 in the efficiency of which was accompanied by an increase in flue heat from 11·5 per cent. to 24·5 per cent. (tests Nos. 25 to 30, and Nos. 31 to 36 [Table 2], averaged) and a decrease in the heat given to air from 48·2 per cent. to 21 per cent. (col. 3, Table 4).

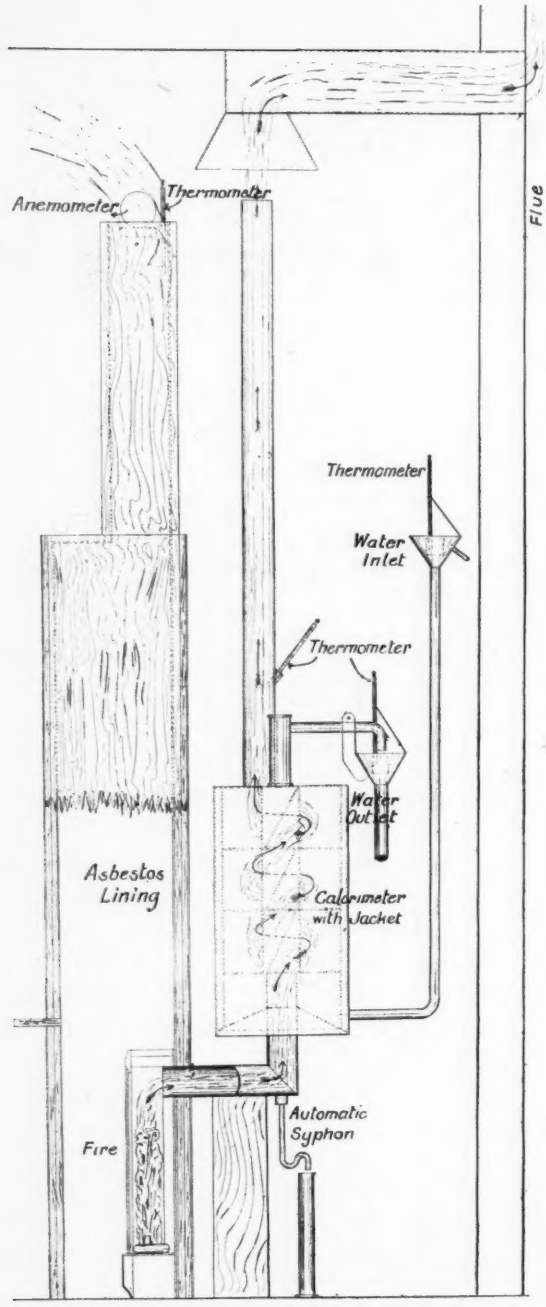



Fig. 10.—Arrangement of Fire, Calorimeter, &c.

*General Observations on Methods of Testing for Radiation, Heated Air, and Flue Heat.*—The results obtained in the separate tests were sufficiently promising to suggest the possibility of combining the three tests, which, if practicable, is certainly better than taking them separately, on different days, and with varying calorific value of gas. In fig. 10 is indicated how this may be done; but this paper passed from the author's hands before he was able to put it sufficiently to the test. The calorimeter illustrated is larger than the one by which the tests in Table No. 2 were taken. It is jacketed with slag wool, the inlet and outlet area being 7·07 inches and 9·62 inches respectively, against 7·07 inches and 5·11 inches in the old one. The outlet of the new one is therefore considerably larger. A test gave an efficiency of 90 per cent.; the outlet gases being slightly over 100° Fahr. This efficiency was but slightly more than that from the smaller and unjacketed calorimeter; so that little loss by conduction was incurred in the latter.

When carrying out the tests for waste heat and heated air, a portion of the products bye-passed up the front of the stove canopy; but analysis and observation have led to the conclusion that, with the stoves used, this would occur under any normal circumstances. Neither the form of hood nor the size of calorimeter seemed to aggravate this. Tests with the new calorimeter show that the old one was big enough for the fires tested.

The hood used in the tests for heated air is rather crude in design; but from the experience obtained, the author has little doubt that a more satisfactory one will be forthcoming. For example, though one would never expect to discover heated air coming out at the front opening, since the latter was (except with one fire) several inches from the front of the fire, and over 4000 cubic feet of heated air was passing out at the top, yet this was found to be the case. It clearly showed that the hood exercised no "pull." To get the tests through without delay, asbestos sheeting was secured to the front, inclining inwards towards the near edge of the canopy of the stove. A pronounced increase in both the volume and the temperature of the air was the result. To meet these defects, the hood has been modified, made 6 inches wider, and an asbestos sheet, mounted on a roller, fitted on. The latter can be extended or shortened at will to suit the varying height and width of stove under test. At the same time the top portion of the hood has been widened.

*Testing for Carbon Monoxide.*—When making these observations on the heat given to air, tests were also made for carbon monoxide, both in the flue products and in the air at the hood outlet. For this purpose Haldane's blood test is often employed; but when minute traces only are present, it is quite inadmissible. The method adopted by the writer is fully described in the supplementary notes to Table No. 3; and although it differs in one or two minor points from any method hitherto employed, it is substantially the one employed by Gautier.* Qualitatively, it has been known for a long time that carbon monoxide would reduce iodine pentoxide; but he (Gautier) is entitled to the credit of showing the extreme sensitiveness of the test when applied under certain conditions. He kept his temperatures at 60° to 80° C., and absorbed the liberated iodine by means of copper, from the increase in weight of which he deduced the equivalent volume of carbon monoxide. This operation demanded a very delicate balance, to avoid which, and also to reduce the time of an experiment, various investigators subsequently employed other and diverse means of absorbing the iodine. Lévy and Pécoul absorbed in chloroform and compared the intensity of colour with those of the members of a series of tubes each of which contained a known amount of iodine dissolved in a known volume of chloroform. These investigators worked at a temperature of 80° C., and their paper is published in "Comptes Rendus de l'Académie des Sciences," Vol. 140, p. 98 (1905).

The writer attempted to use a modified form of Lévy and Pécoul's method; the modification consisting in titrating the iodine with sodium thiosulphate—thus avoiding the preparation of a standard scale of tubes. Under certain circumstances, however, a serious objection to the method was found. The chloroform might be coloured by the iodine, but on adding water the colour would disappear. As fresh chloroform tinted with iodine did not behave in this way, it was concluded that some change, probably oxidation, had been taking place in the chloroform during the passage of the air through it. To overcome this objection, carbon tetrachloride was used (on the suggestion of Dr. Cohen, of Leeds University); and its use proved quite satisfactory.

In a paper entitled "Carbon Monoxide as a Product of Combustion by the Bunsen Burner," by Dr. Thorpe, of the Government Laboratory, and published in the "Journal of the Chemical Society" (Transactions), Vol. 85, p. 318 (1903), some experiments on carbon monoxide are recorded. He used a method devised by Kinnicut and Sanford (a modification of Gautier's), the temperatures employed being from 150 to 155° C. [Details of Kinnicut and Sanford's method are published in the "Journal of the American Chemical Society," 1900, 22, 14.] The reliability of the method was put to the test in the Government laboratory by passing over iodine pentoxide air containing known

* Gautier. "Annales de Chimie et de Physique," Series VII., Vol. 22, p.l., 1901.

TABLE I.—*Gas-Fire Tests. Radiation.*

| Fire. | No. of Test | Condition of Fire. | Gas Consumed per Hour. C. Ft. | Pressure of Gas in Tenths of an Inch. | Area of Fuel in Square Inches. | Calorific Value of Gas. B.Th.U's Gross. | Galvanometer Readings. Nos. Left. 1 | 2 | 3 | Centre. 4 | 5 | 6 | Right. 7 | Total. | Comparative Radiation Value. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* |
| *D* | 1 | Bunsens only. | 19·0 | 11 | — | 603 | 5 | 8·5 | 10 | 10·5 | 10 | 8·5 | 5 | 57·5 | 42 |
| | 2 | ,, | 21·2 | 15 | — | 603 | 6·5 | 10·5 | 12·5 | 13 | 12·5 | 10·5 | 7 | 72 5 | 49 |
| | 3 | ,, | 25·0 | 21 | — | 603 | 8 | 13 | 15·5 | 16 | 15·5 | 13·5 | 8 | 89·5 | 53 |
| | 4 | ,, | 27·7 | 25 | — | 603 | 9·5 | 15 | 18 | 19 | 18·5 | 16 | 10·5 | 106·5 | 55 |
| *D* | 5 | Iron frets. | 19·2 | 10 | — | 604 | 13 | 23 | 30 | 32 | 30 | 23 | 12·5 | 163·5 | 121 |
| | 6 | ,, | 21·2 | 15 | — | 604 | 16·5 | 30 | 37·5 | 40 | 37·5 | 29 | 16·5 | 207 | 139 |
| | 7 | ,, | 25·0 | 20 | — | 604 | 21 | 36 | 45·5 | 47·5 | 45·5 | 35·5 | 20·5 | 251·5 | 142 |
| | 8 | ,, | 27·7 | 25 | — | 604 | 23 | 39 | 49 | 52·5 | 48·5 | 38 | 22 | 272 | 140 |
| *D* | 9 | Fire-clay balls. | 19·2 | 9 | 49 | 626 | 10·5 | 20 | 29 | 30·5 | 28 | 20 | 10·5 | 148·5 | 106 |
| | 10 | ,, | 21·2 | 15 | 49 | 626 | 14·5 | 27 | 37 | 40 | 36 | 26·5 | 14 | 195 | 126 |
| | 11 | ,, | 24·8 | 20 | 49 | 626 | 19·5 | 34 | 45 | 48·5 | 44·5 | 33·5 | 18·5 | 243·5 | 134 |
| | 12 | ,, | 27·7 | 25 | 49 | 626 | 21·5 | 37 | 49 | 54 | 48·5 | 36·5 | 21 | 267·5 | 133 |
| *E* | 13 | Duplex Bunsens only. | 8·1 | 15 | — | 604 | 5 | 9·5 | 13·5 | 14·5 | 13·5 | 9·5 | 5 | 70·5 | 124 |
| | 14 | ,, | 8·9 | 20 | — | 604 | 6·5 | 12 | 16·5 | 17 | 16·5 | 12 | 6·5 | 87 | 139 |
| | 15 | ,, | 9·5 | 25 | — | 604 | 7 | 13 | 17 | 18 | 17 | 13 | 7 | 92 | 137 |
| *E* | 16 | All Bunsens turned down. | 8·2 | 5 | — | 604 | 4 | 8 | 10·5 | 11 | 10·5 | 8 | 3·5 | 55·5 | 96 |
| | 17 | ,, | 9·0 | 7 | — | 604 | 5 | 9 | 12 | 12·5 | 12 | 9 | 5 | 64·5 | 102 |
| | 18 | ,, | 9·3 | 8 | — | 604 | 5 | 9·5 | 12·5 | 13 | 12·5 | 9·5 | 5 | 67 | 102 |
| *E* | 19 | Bunsens normal. | 11·6 | 10 | 56 | 615 | 6·5 | 12·5 | 16·5 | 17·5 | 16·5 | 12·5 | 6 | 88 | 106 |
| | 20 | ,, | 14·1 | 15 | 56 | 615 | 10·5 | 18 | 23·5 | 25 | 24 | 18 | 9·5 | 128·5 | 127 |
| | 21 | ,, | 16·2 | 20 | 56 | 615 | 12 | 22 | 28 | 30 | 28·5 | 22 | 11·5 | 154 | 133 |
| | 22 | ,, | 18·0 | 25 | 56 | 615 | 14 | 25 | 32 | 34 | 32·5 | 25 | 13·5 | 176 | 136 |
| *F* | 23 | ,, | 9·0 | 10 | 42 | 626 | 4 | 9·5 | 12·5 | 13 | 12·5 | 9·5 | 4 | 65 | 99 |
| | 24 | ,, | 10·7 | 15 | 42 | 626 | 6 | 13 | 15·5 | 16·5 | 15·5 | 13 | 6 | 85·5 | 109 |
| | 25 | ,, | 12·3 | 20 | 42 | 626 | 7·5 | 15·5 | 21 | 22 | 21 | 15·5 | 8 | 110·5 | 123 |
| | 26 | ,, | 13·9 | 25 | 42 | 626 | 8·5 | 18 | 23 | 24 | 23 | 18 | 9 | 123·5 | 122 |
| *G* | 27 | ,, | 11·6 | 10 | 60 | 601 | 6 | 9 | 10·5 | 11 | 10·5 | 9 | 6 | 62·0 | 76 |
| | 28 | ,, | 14·0 | 15 | 60 | 601 | 10 | 14 | 17·5 | 18 | 17·5 | 14 | 10 | 101·0 | 103 |
| | 29 | ,, | 15·6 | 20 | 60 | 601 | 11 | 17·5 | 20·5 | 21 | 20·5 | 17 | 11 | 118 5 | 108 |
| | 30 | ,, | 17·1 | 25 | 60 | 601 | 13 | 19 | 23 | 24 | 23 | 19 | 13 | 134·0 | 112 |
| *F* | 31 | With fuel from fire "G." | 8·9 | 10 | 42 | 589 | 4 | 8·5 | 10·5 | 11·5 | 10·5 | 8·5 | 4 | 57·5 | 94 |
| | 32 | ,, | 10·7 | 15 | 42 | 589 | 6 | 12·5 | 16 | 17 | 16 | 12·5 | 6 | 86·0 | 117 |
| | 33 | ,, | 12·3 | 20 | 42 | 589 | 6·5 | 13·5 | 18 | 19 | 18 | 13·5 | 6·5 | 95·0 | 112 |
| | 34 | ,, | 13·9 | 25 | 42 | 589 | 7·5 | 15 | 19·5 | 20·5 | 19·5 | 15 | 7·5 | 104·5 | 109 |
| *G* | 35 | With fuel from fire "F." | 11·7 | 10 | 60 | 578 | 7 | 10 | 11·5 | 12·5 | 11·5 | 10 | 7 | 69·5 | 88 |
| | 36 | ,, | 14·0 | 15 | 60 | 578 | 9·5 | 13·5 | 15 | 16 | 15 | 13·5 | 9·5 | 92·0 | 97 |
| | 37 | ,, | 15·7 | 20 | 60 | 578 | 11·5 | 15·5 | 17·5 | 19 | 18 | 15·5 | 11 | 108·0 | 102 |
| | 38 | ,, | 17·1 | 25 | 60 | 578 | 12·5 | 17 | 19 | 20·5 | 19 | 17 | 11·5 | 116·5 | 101 |
| *H* | 39 | Air tubes at back, depth of fuel, 5½". | 18·3 | 10 | 68 | 603 | 3·5 | 6 | 9 | 9·5 | 9 | 6 | 3·5 | 46·5 | 36 |
| | 40 | ,, | 21·7 | 15 | 68 | 603 | 5 | 8·5 | 12 | 13 | 12·5 | 9 | 5 | 65·0 | 42 |
| | 41 | ,, | 25·0 | 20 | 68 | 603 | 6 | 11 | 15·5 | 16·5 | 15·5 | 11·5 | 6 | 82·0 | 47 |
| | 42 | ,, | 28·3 | 25 | 68 | 603 | 8 | 13·5 | 19 | 19·5 | 19 | 14 | 8 | 101·0 | 50 |
| *H* | 43 | Solid 3" tile at back. Fuel depth 5". | 18·3 | 10 | 68 | 598 | 5·5 | 9 | 13·5 | 14 | 13·5 | 9 | 5·5 | 70·0 | 55 |
| | 44 | ,, | 21·7 | 15 | 68 | 598 | 7 | 12 | 16·5 | 17 | 16·5 | 12 | 7 | 88·0 | 59 |
| | 45 | ,, | 25·0 | 20 | 68 | 598 | 7·5 | 14·5 | 19 | 20 | 19 | 14·5 | 7·5 | 102·0 | 59 |
| | 46 | ,, | 28·3 | 25 | 68 | 598 | 9·5 | 17·5 | 23 | 24 | 23·5 | 17·5 | 9·5 | 124·5 | 63 |
| *H* | 47 | Solid 4½" tile at back. Fuel depth 3½". | 18·3 | 10 | 68 | 613 | 5·5 | 10 | 14 | 14·5 | 14 | 10·5 | 5·5 | 74·0 | 57 |
| | 48 | ,, | 21·7 | 15 | 68 | 613 | 9 | 16 | 21 | 22 | 21 | 16 | 9 | 114·0 | 74 |
| | 49 | ,, | 25·2 | 20 | 68 | 613 | 12 | 21 | 27 | 28 | 27 | 21 | 12 | 148·0 | 82 |
| | 50 | ,, | 28·3 | 25 | 68 | 613 | 14·5 | 24 | 32 | 33·5 | 32·5 | 24·5 | 14·5 | 175·5 | 87 |
| *H* | 51 | Solid 6" tile at back. Fuel depth 2". | 18·1 | 10 | 68 | 611 | 8 | 12 | 15 | 15·5 | 15 | 12·5 | 8·5 | 86·5 | 67 |
| | 52 | ,, | 21·6 | 15 | 68 | 611 | 14 | 21 | 24 | 24·5 | 24 | 21·5 | 14·5 | 143·5 | 93 |
| | 53 | ,, | 25·0 | 20 | 68 | 611 | 18 | 26·5 | 30·5 | 31 | 30·5 | 26·5 | 18 | 181 0 | 102 |
| | 54 | ,, | 29·3 | 25 | 68 | 611 | 22 | 32 5 | 37 | 38 | 37·5 | 32·5 | 22 | 221·5 | 106 |
| *I* | 55 | Air tubes at back. Fuel depth 3". | 17·5 | 10 | 48 | 611 | 9·5 | 12·5 | 16 | 16·5 | 15·5 | 12·5 | 9 | 91·5 | 73 |
| | 56 | ,, | 20·3 | 15 | 48 | 611 | 12·5 | 17·5 | 19·5 | 20·5 | 19·5 | 17·5 | 12 | 119·0 | 82 |
| | 57 | ,, | 23·1 | 20 | 48 | 611 | 14 | 20·5 | 23 | 24·5 | 23 | 20·5 | 13·5 | 139·0 | 84 |
| | 58 | ,, | 25·8 | 25 | 48 | 611 | 16 | 23·5 | 26 | 26·5 | 26 | 23 | 15·5 | 156·5 | 85 |
| *J* | 59 | 5 fireclay tubes, flames in centre. | 7·2 | 15 | — | 590 | 5 | 7·5 | 8·5 | 9 | 8·5 | 7·5 | 5 | 51·0 | 103 |
| | 60 | ,, | 11·1 | 20 | — | 590 | 9 | 12 | 13·5 | 14 | 13·5 | 12 | 9 | 85·0 | 111 |
| | 61 | ,, | 13 5 | 25 | — | 590 | 11 | 14·5 | 17 | 18 | 17 | 14·5 | 11 | 103·0 | 111 |

SUPPLEMENTARY NOTES ON TABLE I.—"COMPARISON OF RADIATION."

Cols. 1 to 7 inclusive are self-explanatory.

The position from which the readings in cols. 8 to 14 inclusive were taken is shown in fig. 3.

Col. 16 is obtained from the following formula:—

$$\frac{\text{Total readings (col. 15)} \times 100 \times 600.}{\text{Actual consumption (col. 4)} \times \text{cal. value (col. 7)} \times 7 \text{ (No. of Galv. readings).}}$$

Thus the figures are reduced to one common standard of 100 cubic feet consumption of gas with a calorific value of 600 B.Th.U. gross.

GAS-FIRE TESTS.

*Time-Table.—Radiation.*

A. M.
9 0.—Light fire, regulate pressure and consumption as required, say for 1 inch pressure.
9 20.—Test with thermopile and galvanometer to see if radiation is constant, and if not repeat until constant, at intervals of five minutes. Then take seven readings in positions marked out.
10 0.—Adjust rate of consumption for tests at next pressure (say 1½ in.).
10 30.—Take readings if fire is constant.
Above procedure repeated for subsequent tests.

P. M.
2 30.—Take calorific value.

quantities of carbon monoxide. The results obtained were as follows:—

| Found. | Percentage Volume Carbon Monoxide in Air Mixture. | Difference. Parts per 100,000. |
|---|---|---|
| 0·197 per cent. | 0·190 | 7 |
| 0·146 ,, ,, | 0·148 | 2 |
| 0·061 ,, ,, | 0·062 | 1 |

The average variation, therefore, was 3⅜ parts per 100,000, which is much greater than any of the results recorded in investigating the presence or otherwise of carbon monoxide in the flue gases or heated air as per Table No. 3. The worst result in the flue gases showed 1·4 parts per 100,000 (Table No. 3, col. 14), while in the heated air passing through the hood, no carbon monoxide was found in 19 tests, and not more than 3·5 parts per million were indicated in any of the other 5 tests. Partially carbonized dust and similar foreign matter will form carbon monoxide; and it has been proved, too, that various combustible substances, such as coal, peat, wood, paper, cork, cellulose, various tissues, tobacco, &c. (when burnt, produce quantities of formaldehyde varying from 1 part per 1000 to 1 part per 100,000 of the weight of the substance burnt; wood and cellulose materials producing the largest quantity. The combustion of hydrocarbons will

TABLE II.—*Gas-Fire Tests. Estimation of Flue Heat.*

| Fire. | No. of Test. | Gas consumed per Hour. C. Ft. | Pressure in Tenths of Inch. | Calorific Value B. Th. U.'s Gross. | Heat Units generated per Hour. | Rate of Water Flow in Lbs. per Hour. | Water Rise in Temp. °F. | Units extracted by Calorimeter. Total. | Units extracted by Calorimeter. Per Cent. | Temperature of Waste Gases. Inlet. °F. | Temperature of Waste Gases. Outlet °F. | Temp. of Room. ° F. | Reduction in Temp. effected by Calorimeter. °F. | Waste Gases passing per Hour. C. Ft. | B. Th. U.'s of Heat carried away. | Units of Heat carried away. Per Cent. | Total Flue Heat. B. Th. U.'s | Total Flue Heat. Per Cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* |
| *D* | 1 | 21·0 | 15 | 605 | 12,700 | 106·7 | 16·8 | 1792 | 14·1 | 494·6 | 77·4 | 48·0 | 417·2 | 215 | 363 | 2·9 | 2155 | 17·0 |
| ,, | 2 | 21·0 | 15 | 605 | 12,700 | 168·7 | 11·6 | 1957 | 15·4 | 494·6 | 71·6 | 51·2 | 423·0 | 231 | 267 | 1·3 | 2224 | 16·7 |
| ,, | 3 | 24·5 | 20 | 605 | 14,820 | 181·8 | 12·1 | 2200 | 14·8 | 516·2 | 68·5 | 55·8 | 447·7 | 247 | 171 | 1 1 | 2371 | 16·0 |
| ,, | 4 | 24·5 | 20 | 605 | 14,820 | 128·0 | 16·9 | 2163 | 14·6 | 516·2 | 70·7 | 59·5 | 445·5 | 242 | 167 | 1·1 | 2330 | 15 7 |
| ,, | 5 | 27·7 | 25 | 599 | 16,590 | 155·9 | 14·0 | 2183 | 13·2 | 536·0 | 72·5 | 54·6 | 463·5 | 236 | 236 | 1·4 | 2419 | 14·6 |
| ,, | 6 | 27·7 | 25 | 599 | 16,590 | 145·4 | 14·9 | 2166 | 13·1 | 536·9 | 73·4 | 51·9 | 463·5 | 234 | 270 | 1·6 | 2436 | 14·7 |
| *E* | 7 | 13·8 | 15 | 593 | 8,180 | 176·5 | 9·2 | 1624 | 19·8 | 365·0 | 87·8 | 52·3 | 277·2 | 293 | 697 | 8·5 | 2321 | 28·4 |
| ,, | 8 | 13·6 | 15 | 593 | 8,060 | 151·3 | 10·7 | 1619 | 20·1 | 365·0 | 87·8 | 52·8 | 277·2 | 292 | 697 | 8·6 | 2316 | 28·7 |
| ,, | 9 | 15·8 | 20 | 593 | 9,370 | 152 2 | 11·9 | 1811 | 19 3 | 388·4 | 86·4 | 55·5 | 302·0 | 300 | 624 | 6·7 | 2435 | 26·0 |
| ,, | 10 | 15·8 | 20 | 586 | 9,260 | 197·7 | 9·5 | 1878 | 20·3 | 390·2 | 83·7 | 54·5 | 301·5 | 311 | 597 | 6·4 | 2475 | 26·7 |
| ,, | 11 | 17·4 | 25 | 586 | 10,190 | 186·5 | 10·7 | 1995 | 19·6 | 399·2 | 91·7 | 56·6 | 307·5 | 324 | 847 | 8 3 | 2842 | 27·9 |
| ,, | 12 | 17·4 | 25 | 586 | 10,190 | 156·5 | 12·7 | 1986 | 19·5 | 399·2 | 90·3 | 56·6 | 308·9 | 321 | 790 | 7·7 | 2776 | 27·2 |
| *F* | 13 | 11·7 | 15 | 594 | 6,950 | 102·9 | 18·1 | 1862 | 26·8 | 510·8 | 87·8 | 59·8 | 423·0 | 220 | 439 | 6 3 | 2301 | 33·1 |
| | 14 | 12·1 | 15 | 604 | 7,310 | 80·3 | 23·6 | 1895 | 25·9 | 505·4 | 90·5 | 60·0 | 405·9 | 233 | 519 | 7 1 | 2414 | 33·0 |
| | 15 | 14·0 | 20 | 604 | 8,460 | 221·6 | 9·4 | 2083 | 24·6 | 546·8 | 88·7 | 60·0 | 458·1 | 227 | 455 | 5·4 | 2538 | 30·0 |
| | 16 | 13·7 | 20 | 600 | 8,220 | 234·3 | 8·8 | 2061 | 25·1 | 533·6 | 85·1 | 55·0 | 448·5 | 230 | 460 | 5·4 | 2521 | 30·5 |
| | 17 | 16·4 | 25 | 600 | 9,840 | 216·1 | 9·7 | 2096 | 21·3 | 540·4 | 85·1 | 57·0 | 455·3 | 230 | 425 | 4 3 | 2521 | 25 6 |
| | 18 | 16·1 | 25 | 600 | 9,660 | 203·6 | 10·7 | 2178 | 22·5 | 554·0 | 82·2 | 57·0 | 464·8 | 234 | 378 | 3·9 | 2556 | 26·5 |
| *G* | 19 | 14·0 | 15 | 608 | 8,510 | 147·6 | 12 2 | 1800 | 21·1 | 325·6 | 79·7 | 50·2 | 245·9 | 366 | 646 | 7·6 | 2446 | 28 7 |
| | 20 | 14·0 | 15 | 608 | 8,510 | 109·5 | 16·5 | 1807 | 21·2 | 326·3 | 81 9 | 50·7 | 244·4 | 370 | 712 | 8·4 | 2519 | 29·6 |
| | 21 | 15·3 | 20 | 570 | 8,720 | 165·8 | 11·0 | 1824 | 20·9 | 345·2 | 77·7 | 47·3 | 267·5 | 341 | 576 | 6·6 | 2400 | 27·5 |
| | 22 | 15·3 | 20 | 570 | 8,720 | 99·5 | 17·0 | 1692 | 19·4 | 347·0 | 83·3 | 50·0 | 263·7 | 321 | 642 | 7·4 | 2334 | 26·8 |
| | 23 | 17·4 | 25 | 570 | 9,920 | 149·6 | 13·5 | 2020 | 20·4 | 393·8 | 84·2 | 51·0 | 309·6 | 326 | 678 | 6·8 | 2698 | 27·2 |
| | 24 | 17·4 | 25 | 570 | 9,920 | 126·3 | 15·6 | 1970 | 19·9 | 393·8 | 85·1 | 52·5 | 308·7 | 314 | 651 | 6·6 | 2621 | 26·4 |
| *H* | 25 | 21·7 | 15 | 599 | 13,000 | 172·3 | 8·2 | 1415 | 10·9 | 388·4 | 77·4 | 64·3 | 311·0 | 227 | 175 | 1·3 | 1590 | 12·2 |
| (Air | 26 | 21·7 | 15 | 599 | 13,000 | 160·7 | 8·7 | 1398 | 10·7 | 390·2 | 76·1 | 65·0 | 314·1 | 223 | 154 | 1·2 | 1552 | 11·9 |
| tubes | 27 | 25·0 | 20 | 600 | 15,000 | 147·6 | 9·7 | 1432 | 9·5 | 399·2 | 77·9 | 65·0 | 321·3 | 223 | 188 | 1 2 | 1620 | 10·8 |
| and air | 28 | 25·0 | 20 | 600 | 15,000 | 138·6 | 10·7 | 1483 | 9·9 | 401·0 | 80·4 | 66·5 | 320 6 | 231 | 231 | 1·5 | 1714 | 11 4 |
| heating | 29 | 28·3 | 25 | 600 | 16,980 | 133·6 | 12·2 | 1629 | 9·6 | 410·0 | 80 8 | 59·0 | 329·2 | 248 | 363 | 2·1 | 1992 | 11·7 |
| chamber. | 30 | 28·3 | 25 | 600 | 16,980 | 138·2 | 11·3 | 1562 | 9·2 | 411·8 | 82·4 | 63·2 | 329·4 | 237 | 309 | 1·8 | 1871 | 11·0 |
| *H* | 31 | 22·1 | 15 | 598 | 13,220 | 171·0 | 13·3 | 2274 | 17·2 | 430·2 | 90·2 | 52·6 | 337·0 | 337 | 881 | 6·6 | 3155 | 23·8 |
| (Solid | 32 | 22·1 | 15 | 598 | 13,220 | 135·4 | 15·2 | 2058 | 15·6 | 430·8 | 96·8 | 57·0 | 334·0 | 308 | 972 | 7·3 | 3030 | 22·9 |
| tiled | 33 | 24·6 | 20 | 600 | 14,760 | 113·5 | 20·0 | 2270 | 15·4 | 469·4 | 107·4 | 50·5 | 362·0 | 313 | 1542 | 10·4 | 3812 | 25 8 |
| back) | 34 | 24·6 | 20 | 600 | 14,760 | 163·1 | 14·7 | 2398 | 16·2 | 469·4 | 104·9 | 54·0 | 364·5 | 329 | 1442 | 9 8 | 3840 | 26·0 |
| | 35 | 30·2 | 25 | 602 | 18,180 | 93·1 | 29·0 | 2700 | 14·8 | 530·6 | 110·3 | 50·0 | 420·3 | 321 | 1754 | 9·6 | 4454 | 24·5 |
| | 36 | 30·3 | 25 | 602 | 18,180 | 191·7 | 14·9 | 2856 | 15·7 | 530·6 | 105·8 | 53·5 | 424·8 | 336 | 1548 | 8·5 | 4404 | 24·2 |
| *I* | 37 | 20·3 | 15 | 609 | 12,360 | 159·6 | 6·0 | 958 | 7·7 | 327·2 | 68·0 | 60·5 | 259·2 | 185 | 85 | ·7 | 1043 | 8·4 |
| | 38 | 20·3 | 15 | 609 | 12,360 | 170·4 | 5·5 | 937 | 7·6 | 327·2 | 67·6 | 62·0 | 259·6 | 180 | 69 | ·6 | 1006 | 8·1 |
| | 39 | 22·9 | 20 | 605 | 13,850 | 152 8 | 6·1 | 932 | 6·7 | 339·8 | 70·7 | 56·0 | 269·1 | 173 | 133 | 1·0 | 1028 | 7·7 |
| | 40 | 22·9 | 20 | 605 | 13,850 | 109·3 | 8·0 | 874 | 6 3 | 339·8 | 73·8 | 56·0 | 266·0 | 164 | 176 | 1·3 | 1050 | 7·6 |
| | 41 | 25·7 | 25 | 605 | 15,550 | 162·5 | 6·9 | 1121 | 7·2 | 365·0 | 74·1 | 66·3 | 290·9 | 193 | 104 | ·7 | 1225 | 7·9 |
| | 42 | 25·7 | 25 | 605 | 15,550 | 169·0 | 7·0 | 1183 | 7·6 | 365·0 | 75·0 | 70·3 | 290·0 | 204 | 78 | ·5 | 1261 | 8·1 |
| *J* | 43 | 7·2 | 15 | 567 | 4,080 | 114·4 | 4·2 | 480 | 11·8 | 293·0 | 47·9 | 53·7 | 245·1 | 98 | —30 | —·7 | 450 | 11·0 |
| | 44 | 7·2 | 15 | 567 | 4,080 | 144·2 | 3·2 | 461 | 11·3 | 294·8 | 46·8 | 54·0 | 248·0 | 93 | —28 | —·7 | 433 | 10·6 |
| | 45 | 11·1 | 20 | 589 | 6,540 | 128·3 | 5·1 | 654 | 10·0 | 367·7 | 49·1 | 53·6 | 318·6 | 103 | —24 | —·4 | 630 | 9·6 |
| | 46 | 11·1 | 20 | 589 | 6,540 | 126 3 | 5·4 | 682 | 10·4 | 368·6 | 49·5 | 55·0 | 319·1 | 107 | —25 | —·4 | 657 | 10·0 |
| | 47 | 13·5 | 25 | 567 | 7,650 | 147·6 | 5·0 | 738 | 9 6 | 420·8 | 48·6 | 50·5 | 372·2 | 99 | —15 | —·2 | 723 | 9·5 |
| | 48 | 13·5 | 25 | 567 | 7,650 | 137·1 | 5·2 | 713 | 9·3 | 422·6 | 48 2 | 52·0 | 374·4 | 95 | —22 | —·3 | 691 | 9·0 |

*Remarks.*—Area of stove flue pipes was as follows: D, 1·78 sq. in.; E, 6·12 sq. in.; F, 3·31 sq. in.; G, 6·50 sq. in.; H, 7·00 sq. in.; I, 7 sq. in.; J, 0·44 sq. in. (outlet).

## SUPPLEMENTARY NOTES ON TABLE II., "ESTIMATION OF FLUE HEAT."

Cols. 1 to 5 are self-explanatory. Fig. 4 shows the position of the test-meter and pressure-gauge respectively.

Col. 6 is the multiplicand of figures in cols. 3 and 5 respectively, units being discarded.

Col. 9 is the multiplicand of cols. 7 and 8.

Col. 10 is the ratio of col. 9 to col. 6. The temperatures in cols. 11 and 12 were taken by suitable thermometers in degrees Centigrade, and the latter converted into degrees Fahrenheit for convenience of calculation.

The temperature of the room (col. 13) was arrived at by taking the mean of two thermometers placed 6 feet from the floor, not less than 4 feet from any wall, and unexposed to radiant heat. The fresh air supply to the room was drawn from a Tobin's tube, the outlet of which was 5 feet above the floor level.

Col. 14 is the difference between cols. 12 and 11.

Col. 15 is obtained by multiplying the units extracted (col. 9) by 13 (the approximate weight of 1 lb. of waste gases), and dividing by the figure in col. 14 multiplied by 0·26, the approximate specific heat of the waste gases, thus:—

*Test No. 1.*

$$\frac{1792 \times 13}{417{\cdot}2 \times 0{\cdot}26} = 215 \text{ (about)}.$$

Col. 16.—It was found by calculation and reference to Glaisher's tables that in every case the waste gases were fully saturated with aqueous vapour at the outlet of the calorimeter. A curve was prepared (Diagram 5) showing the units of heat carried away by 1 lb. of fully saturated air (waste products being taken as such) at various temperatures. The number of units in a fall of temperature from that of the outlet gases (col. 12) to the room temperature (col. 13) was thus readily obtained. Example:—

*Test No. 1.*

Outlet temperature, 77·4°; room temperature, 48°. The curve shows that 1 lb. of saturated air at the former temperature contains 33 B.Th.U., and at the latter temperature 11 B.Th.U.; the difference being 22. The 215 cubic feet of waste gases (col. 15) weigh approximately 16·5 lbs. Then $22 \times 16{\cdot}5 = 363$ (units carried away).

Col. 17 is the ratio of col. 16 to col. 6.

Cols. 18 and 19 are self-explanatory.

In order to connect the calorimeter with the respective fires under test, special galvanized bends were used, with provision for automatically syphoning away products of condensation (fig. 6). No correction is made in this table for the latter, as the flue heat is compared against the total "gross" B.Th.U. of the gas used, as ascertained by a Junkers calorimeter. The area of the inlet to the calorimeter was 7·07 inches, and the outlet 5·11 inches.

*Time Table.—Flue Heat.*

A.M.

9.0.—Light fire, and regulate pressure of gas as required.

10.0.—Temperature of heated water in calorimeter is constant. Pass 25 lbs. of water through, and note time taken. Take six observations of temperature of hot water, and average, and one observation of cold water. Two observations are taken of temperature of flue products at the outlet of the calorimeter, one at the beginning and one at the end, and average.

10.20.—Take readings of four thermometers placed 6 feet from the floor at different parts of the room, but avoiding direct rays of radiation. These indicate the temperature of the air of combustion. The above is repeated for subsequent tests, and the calorific value of the gas is taken each day at 3 p.m.

produce formaldehyde; the quantity increasing with the complexity of the homologue. Formaldehyde will probably liberate iodine from iodine pentoxide in the same way as carbon monoxide does; and if this is the case, even the minute traces indicated may not be carbon monoxide, but formaldehyde. Taking into consideration all these facts, one may say that gas-fires do not produce carbon monoxide when properly constructed and kept clean. It has been proved that when a gas-flame comes into contact with cold surfaces, carbon monoxide is produced. But so far as gas-fires are concerned, this is almost entirely avoidable; and, indeed, if neglected, it only concerns the first few seconds after the fire is lit. It has been put forward, however, as an objection to gas-fires; and from the method here given of estimating carbon monoxide, some other member may be disposed to make experiments thereon with various fires immediately after lighting up.

*Flueless Stoves.*—There can be no doubt about it that, unless the outlets for ventilation in the upper portions of a room are adequate, and the stoves themselves are protected somewhat from persons "lounging" round them, flueless stoves should not be fixed in living or workrooms. A considerable number of tests were made upon them, utilizing the hood, chiefly with a view to ascertaining to what extent

TABLE III.—*Heated Air (Convection).*

| Fire. | No. of Test. | Pressure of Gas in tenths of an Inch. | Calorific Value B.Th. Units Gross. | Consumption per Hour. C.Ft. | Total Units per Hour. | Temperature of Air | | | Air Passed per Hour (Corrected) C. Ft. | Air Passed per Hour. Lbs. | Heat in Air Passed Through. | | Carbon Monoxide Parts per 100,000 | | Carbonic Acid per Cent. | | | $CO_2$ Passing up Hood per Hour. C. Ft. | Total $CO_2$ Produced per Hour. C. Ft. | Waste Gases Bye-Passing per Hour. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | At Inlet of Hood. | At Outlet of Hood. | Difference. | | | B.Th. Units. | Per Cent. of Total | In Flue Gas. | In Heat'd Air. | At Inlet. | At Outlet. | Excess at Outlet. | | | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* |
| *D* | 1 | 15 | 571 | 21·0 | 11,990 | 52·0 | 111·9 | 59·9 | 4980 | 349 | 5020 | 41·9 | ·70 | — | ·106 | ·157 | ·051 | 2·54 | 10·92 | 23·3 |
| | 2 | 20 | 578 | 24·5 | 14,160 | 63·0 | 133·0 | 70·0 | 5050 | 353 | 5930 | 41·9 | ·87 | ·35 | ·102 | ·172 | ·070 | 3·53 | 12·74 | 27·7 |
| | 3 | 25 | 616 | 26·9 | 16,570 | 57·0 | 128·7 | 71·7 | 5180 | 363 | 6240 | 37·7 | 1·22 | ·35 | 081 | ·172 | ·091 | 4·71 | 13·99 | 33·6 |
| *E* | 4 | 15 | 588 | 14·0 | 8,230 | 49·0 | 86·4 | 37·4 | 4050 | 283 | 2540 | 30·9 | ·35 | — | ·093 | ·142 | ·049 | 1·98 | 7·28 | 27·2 |
| | 5 | 20 | 616 | 15·8 | 9,740 | 57·5 | 104·7 | 47·2 | 4120 | 288 | 3270 | 33·5 | ·35 | — | ·098 | ·163 | ·065 | 2·68 | 8·22 | 32·6 |
| | 6 | 25 | 578 | 17·4 | 10,060 | 55·0 | 102·0 | 47·0 | 4130 | 289 | 3260 | 32·4 | ·35 | — | ·088 | ·151 | ·063 | 2·60 | 9·05 | 28·7 |
| *F* | 7 | 15 | 593 | 12·0 | 7,110 | 49·5 | 86·0 | 36·5 | 3500 | 245 | 2150 | 30·2 | ·35 | — | ·072 | ·114 | ·042 | 1·47 | 6·24 | 23·5 |
| | 8 | 20 | 573 | 14·0 | 8,020 | 55·0 | 92·6 | 37·6 | 3950 | 276 | 2500 | 31·2 | ·35 | — | ·100 | ·161 | ·061 | 2·41 | 7·28 | 33·1 |
| | 9 | 25 | 573 | 16·3 | 9,340 | 61·0 | 103·2 | 42·2 | 4030 | 282 | 2860 | 30·6 | ·35 | — | ·102 | ·168 | ·066 | 2·66 | 8·48 | 31·4 |
| *G* | 10 | 15 | 588 | 14·0 | 8,230 | 51·5 | 78·1 | 26·6 | 3460 | 242 | 1540 | 18·7 | ·35 | — | ·075 | ·098 | ·023 | ·80 | 7·28 | 11·0 |
| | 11 | 20 | 574 | 15·3 | 8,780 | 55·0 | 86·0 | 31·0 | 3520 | 246 | 1830 | 20·8 | ·35 | — | ·077 | ·142 | ·065 | 2·29 | 7·96 | 28·8 |
| | 12 | 25 | 574 | 17·4 | 9,990 | 62·0 | 98·0 | 36·0 | 3630 | 254 | 2190 | 21·8 | ·52 | — | ·080 | ·147 | ·067 | 2·43 | 9 05 | 27·0 |
| *H* | 13 | 15 | 588 | 21·7 | 12,760 | 51·0 | 117·9 | 66·9 | 5170 | 362 | 5810 | 45·5 | ·35 | — | ·098 | ·172 | ·074 | 3·83 | 11·28 | 34·0 |
| tubes | 14 | 20 | 573 | 25·0 | 14,320 | 61·0 | 139·7 | 78·7 | 5270 | 369 | 6970 | 48·7 | ·35 | — | ·094 | ·180 | ·086 | 4·53 | 13·00 | 34·8 |
| | 15 | 25 | 588 | 28·3 | 16,640 | 57·5 | 145·5 | 88·0 | 5670 | 397 | 8380 | 50·4 | ·52 | — | ·108 | ·198 | ·090 | 5·10 | 14·72 | 34·6 |
| *H* | 16 | 15 | 580 | 22·0 | 12,760 | 60·0 | 102·5 | 42·5 | 3500 | 245 | 2500 | 19·6 | ·70 | — | ·085 | 163 | ·078 | 2·73 | 11·44 | 23·9 |
| tiled | 17 | 20 | 579 | 25·0 | 14,470 | 56 0 | 100·4 | 44·4 | 3840 | 269 | 2860 | 19·8 | ·70 | — | ·089 | ·172 | ·083 | 3·19 | 13·00 | 24·5 |
| | 18 | 25 | 579 | 28·3 | 16,390 | 62·0 | 113·4 | 51·4 | 4470 | 313 | 3860 | 23·5 | 1·05 | — | ·092 | ·180 | ·088 | 3·93 | 14·72 | 26·7 |
| *I* | 19 | 15 | 580 | 20·0 | 11,600 | 58·5 | 114·5 | 56·0 | 4500 | 315 | 4230 | 36·5 | 1·05 | ·35 | ·090 | 173 | ·083 | 3·73 | 10·40 | 35·8 |
| | 20 | 20 | 556 | 22·9 | 12,730 | 55·0 | 113·2 | 58·2 | 4810 | 337 | 4700 | 36·9 | 1·05 | ·35 | ·098 | ·182 | ·084 | 4·04 | 11·91 | 33·9 |
| | 21 | 25 | 556 | 25·7 | 14,290 | 61·0 | 128·2 | 67·2 | 5020 | 351 | 5670 | 39 6 | 1·40 | ·35 | ·106 | ·224 | ·118 | 5·92 | 13·36 | 44·3 |
| | 22 | 15 | 598 | 7·2 | 4,310 | 53·0 | 87·9 | 34·9 | 3380 | 237 | 1980 | 45·9 | ·70 | — | ·085 | ·136 | ·051 | 1·72 | 3·74 | 46·0 |
| | 23 | 20 | 567 | 11·1 | 6,290 | 53·0 | 92·0 | 39·0 | 4270 | 299 | 2800 | 44·5 | 1·05 | — | ·098 | ·169 | ·071 | 3·03 | 5·77 | 52·5 |
| | 24 | 25 | 567 | 13·5 | 7,660 | 58·0 | 104·7 | 46·7 | 4510 | 316 | 3540 | 46·2 | 1·05 | — | ·102 | ·186 | ·084 | 3·79 | 7·02 | 54·0 |

SUPPLEMENTARY NOTES ON TABLE III.

Col. 6 is the multiplicand of cols. 4 and 5, units being ignored.

The temperature at the inlet (col. 7) was ascertained by placing a thermometer about 3 feet from the hood, in a direct line between the hood and the Tobin inlet air-tube. It was first ascertained that the supply of air to the gas-fire was drawn chiefly in this direction. The thermometer was protected from radiation.

The temperature at the outlet (col. 8) was found to vary *slightly* according to the position or side upon which the thermometer was placed, even though the bulb in each case was the same distance (about 4 inches) down the hood. Consequently, the clip which secured the thermometer was moved in turn to each of the four sides, and the average of the four readings taken.

The air passed through the hood (col. 10) was measured by an anemometer, and corrected in each case to the volume of 62° Fahr. From the corrected volume col. 11 was obtained from the factor "1 cubic foot of air weighs 0·07 lb."

Col. 12 is the multiplicand of cols. 9, 11, and 0·24 (the specific heat of air). Units are ignored.

*Testing for Carbon Monoxide* (Cols. 14 and 15).

Fig. 8 is a sketch of the apparatus used for ascertaining the presence or otherwise of carbon monoxide in the air or flue gases. A is a bottle of about 10 litres capacity, which is kept nearly full of distilled water. Connected to it by a flexible tube M, of ¼ inch bore, is a graduated bottle B of 25 litres capacity. This is provided with a rubber bung and delivery-tube with stopcock C, to which are joined large U-tubes D, E, and F, containing soda-lime, topped with glass wool. To these are connected bottles G and H (½ litre capacity each), one-third full of strong sulphuric acid. Tube I, filled with glass wool, is joined to them; and to this is connected tube J, filled with alternate layers of glass wool and iodine pentoxide, the latter having previously been prepared by passing over it a large quantity of oxygen while the pentoxide was kept at a temperature of 80° C. Tube J is immersed in an oil bath supported on a tripod stand. Connected to it is a Winkler's worm K, supported on a wood block L, and containing pure carbon tetrachloride.

To carry out the test, bottle B is filled with distilled water, tube M is clipped, and the tube at O disconnected, and re-connected to the supply of gas to be tested. Cock C is opened, and a sample drawn into the bottle B by disconnecting at N, after which C is shut again, and tubes at N and O re-connected. The clip is then taken from the tube M; thus putting the water of the two bottles into communication. In the meantime, the oil bath is heated up to a temperature of 80° C. The two cocks P in the U-tube J are then opened, and cock C slightly opened; about two litres of the gas being thus allowed to pass through the apparatus. When the water has reached a mark in the 25-litre bottle B, the worm containing the carbon tetrachloride is connected; and while the bath is carefully kept at 80° C., 8 litres of the gas are allowed to pass through at the rate of 4 litres per hour. The contents of the worm are then poured into a clean dry titrating flask and N/100 sodium thiosulphate added drop by drop until the pink coloration, if there be any, entirely disappears; the addition of each drop being accompanied by vigorous shaking. Calculation is then made as follows:—

Assuming 0·2 of a c.c. of sodium thiosulphate is used, then—

$$\frac{0{\cdot}2 \times 112}{200 \times 8000 \text{ (c.c. of gas passed)}} = 1{\cdot}4 \text{ parts CO per 100,000.}$$

Before an actual test of the sample of air or gases to be analyzed is taken, a blank test of air from outside must first be made as described above, and the result obtained must be deducted from the results of any tests of gases made on the same day. If the blank test indicates 0·3 parts per 100,000, this deducted from the example given above would give the corrected result 1·1 parts per 100,000.

Care must be taken that—(1) The titrating flask and the worm are thoroughly cleaned before each test, being washed out with aqua regia, and occasionally with ether and alcohol as well, and then dried; (2) the gas passes through at not more than 4 litres per hour, as otherwise there is a liability to blow some of the iodine pentoxide into the worm, thus spoiling the test.

The principle of the above test for carbon monoxide is that CO liberates iodine from iodine pentoxide at 80° C., and the liberated iodine is absorbed by the carbon-tetrachloride.

In actual practice, as above, it was found that a single drop of sodium thiosulphate was equal to an indication of 0·35 part per 100,000 of carbon monoxide. The susceptibility of the test would therefore be increased by passing an increased volume of air through before titrating.

The sample of carbonic acid (col. 16) was taken in the same position as the temperature of the ingoing air was recorded (col. 7). The sample of carbonic acid (col. 17) was taken 8 inches below the top of the hood. Wanklyn's bottle method was used for testing; barium hydrate being used as absorbent, phenol phthalein as indicator, and oxalic acid as neutralizer.

The carbonic acid passing per hour (col. 19) is obtained from cols. 10 and 18.

The total carbonic acid produced (col. 20) is obtained by multiplying the figure in col. 5 by 0·52, the carbonic acid produced by the combustion of 1 cubic foot of gas.

Col. 21 is the percentage ratio of col. 19 to col. 20.

*Time Table.—Tests for Heated Air.*

A.M.

9. 0.—Fire being fixed in position under hood, light gas, and adjust for pressure or consumption.

9.10.—Draw a sample of air from outside window for blank test for carbon monoxide, and start this test as soon as possible.

11.45.—Draw sample of flue products into 25-litre bottle, and test for carbon monoxide.

P.M.

2.30.—Draw sample of air from 6 inches below top of hood into 25-litre bottle, and commence test for CO.

3. 0.—Take sample of air from 6 inches below top of hood, and test for carbonic acid in Wanklyn's bottle (carbon monoxide test is proceeding at the time).

3.30.—Take sample of inlet air, and test for $CO_2$.

3.35.—Take reading of thermometer indicating temperature of inlet air, and also of thermometer at top of hood.

3.45.—Take a ten-minutes observation of anemometer at top of hood, and calculate rate of flow of heated air,

4.30.—Test gas for calorific value.

carbonic acid escaped into the room, and also to test for the presence of carbon monoxide. The amount of carbonic acid varied in a stove combining condensing tubes with flat-flame burners and a copper reflector, upwards. Two different makes of steam-radiators passed practically the whole of the carbonic acid into the room. Tests for carbon monoxide were of a similar order to those made on the flue gases of gas-fire stoves; the highest of eight tests being 1·05 parts, and the lowest 0·35 part per 100,000.

Flueless stoves, after all, are not so economical of heat as is often concluded. The heat imparted, being chiefly by convection, a rapid motion of the air in an upward direction is caused, and hygienic considerations demand that it should be "hustled" out of the room at the ceiling, almost, if not quite, as rapidly as it ascends. Yet all the while the objects in the room will remain comparatively cold. Without having actually made tests, it is difficult to conceive how such stoves can effect much economy as compared with a properly-designed gas-fire stove, if the same standard of purity of atmosphere is maintained. If gas-fires are to win popular favour—and the most optimistic member cannot say they have done so yet—they must take the form which retains the valuable function of aiding, if not completing, ventilation.

TABLE IV.

| Fire. | Average Consumption. Cubic Feet. | Heat in Air. Per Cent. of Total. | Waste Products Bye-Passing. Per Cent. | Area of Stove Flue-Pipe. Sq. Inches. | Area per c. ft. of Gas Consumed. Sq. Inches. | Area of Hood over Fuel. Sq. Inches. | Hood Area per c. ft. of Gas Consumed. Sq. Inches. | Distance (travel) to Outlet of Stove Flue from Bunsens. Inches. |
|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| *D* | 24·1 | 40·5 | 28·2 | 1·78 | 0·07 | 7·1 | 0·29 | 16 |
| *E* | 15·7 | 32·3 | 29·6 | 6·12 | 0·39 | 10·0 | 0·68 | 15 |
| *F* | 14·1 | 30·7 | 29·3 | 3·31 | 0·23 | 10·5 | 0·74 | 12 |
| *G* | 15·6 | 20·7 | 22·3 | 6·50 | 0·42 | 21·0 | 1·35 | 16 |
| *H* (air tubes) | 25·0 | 48·2 | 34·5 | 7·00 | 0·28 | * | — | 18 |
| *H* (solid tile) | 25·1 | 21·0 | 25·0 | 7·00 | 0·28 | 34·0 | 1·35 | 18 |
| *I* | 22·9 | 37·7 | 37·0 | 7·00 | 0·30 | * | — | 18 |
| *J* | 10·6 | 45·5 | 50·8 | 0·44 | 0·04 | 6 5 | 0·61 | 23 |

* In these fires the products passed between the air-tubes at the back of the "fuel" to the stove flue-pipe,

TABLE V.—*Gas-Fire Tests. Humidity and Hygiene.*

| No. | Fire. | Consumption of Gas Per Hour. Cub. Ft. | Calorific Value of Gas, B.Th.U's. | | Temperature Incoming Air. | | Temperature of Room.* | | Humidity. | | Air and Products passed up Flue per Hour. Cub. Ft. | No. of times Air changed per Hour. | $CO_2$ in Air of Room at 3 p.m. Per Cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gross. | Net. | At 10 a.m. °F. | At 4 p.m. °F. | At 10 a.m. °F. | At 4 p.m. °F. | At 10 a.m. | At 4 p.m. | | | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* |
| 1 | *E* | 12·72 | 566 | 504 | 43·5 | 48·0 | 46·5 | 60·0 | 86·0 | 86·0 | 4·300 | 2·1 | ·087 |
| 2 | ,, | 15·13 | 564 | 494 | 42·5 | 49·0 | 45·5 | 63·0 | 81·5 | 83·0 | 5·500 | 2·7 | ·095 |
| 3 | ,, | 14·91 | 574 | 502 | 42·0 | 43·0 | 48·0 | 60·0 | 86·0 | 86·0 | 4·200 | 2·1 | ·094 |
| 4 | ,, | 12·91 | 551 | 497 | 41·0 | 44·5 | 45·0 | 59·0 | 80·5 | 83·0 | 4 200 | 2·1 | ·106 |
| 5 | *A* | 37·92 | 577 | 512 | 38·0 | 41·0 | 43·0 | 66·5 | 88·0 | 67·0 | 7·400 | 3·6 | ·119 |
| 6 | ,, | 42·50 | 581 | 518 | 42·0 | 46·5 | 46·0 | 75·0 | 92·0 | 70·5 | 8·000 | 3·4 | ·194 |
| 7 | *B* | 34·16 | 590 | 520 | 50·5 | 54·0 | 51·5 | 74·0 | 93·0 | 75·5 | 7·500 | 3·7 | ·173 |
| 8 | ,, | 39·44 | 587 | 519 | 50·0 | 49·5 | 51·0 | 75·0 | 93·0 | 70·5 | 7·900 | 3·9 | ·165 |
| 9 | *C* | 25·82 | 562 | 500 | 48·0 | 48·5 | 50·5 | 66·5 | 89·5 | 77·0 | 4·200 | 2·0 | ·144 |
| 10 | ,, | 28·33 | 572 | 504 | 47·0 | 48·0 | 50·0 | 71·0 | 93·0 | 70·5 | 6·700 | 3·3 | ·177 |
| 11 | *B* | 34·72 | 570 | 502 | 46·0 | 50·0 | 51·0 | 72·0 | 86·0 | 64·0 | 8·100 | 4·0 | ·157 |
| 12 | ,, | 40·76 | 560 | 497 | 40·0 | 43·0 | 47·5 | 72·0 | 86·0 | 64·0 | 10 200 | 5·0 | ·142 |

*Average of Five Thermometers.

It is safe to say that not less than 90 per cent. of the property which is being erected even to-day is dependent solely upon the coal-fire flue for its ventilation. In property erected for the artisan classes this is practically the case without exception. In this way a serious obstacle to the extension of the use of gas for heating is being perpetuated, for its inherent value as a ventilating agent is thus ignored. It is our duty as gas engineers to leave no stone unturned to produce as speedily as possible a change in such antiquated methods of design.

*Earlier Experiments.*—When attention was first turned to the present subject, the methods adopted for ascertaining the relative value of gas-fires for heating rooms were somewhat similar to those subsequently used in the Coal Smoke Abatement Commission's tests. After several weeks' observations, it was decided to abandon the method of merely taking the temperatures of the room at various points, and averaging. The more one proceeded in this way, the more obvious it became that, through circumstances entirely outside the merits of the fire itself, an injustice could be done by drawing up a "table of comparison" from results thus obtained. The fresh air supply to the room was drawn through a Tobin's tube, which delivered at a point 5 feet above the floor level. This inlet was on the north-east side of the room, and therefore uninfluenced by the sun's rays; it was greatly sheltered, too, from the wind. Nevertheless, most tantalizing variations in the temperature of the ingoing air occurred. In the first twelve observations, taken on separate days in the months of January and February, 1906, the following variations of the inlet thermometer were recorded at 4 p.m., as compared with 10 a.m.:—

Increases, degrees Fahr. $4\frac{1}{2}$, $6\frac{1}{2}$, 1, $3\frac{1}{2}$, 3, $4\frac{1}{2}$ $3\frac{1}{2}$, $\frac{1}{2}$, 1, 4, 3.
Decrease „ „ $\frac{1}{2}$.

From extremes, therefore, there was a variation of 7° Fahr., and when the temperature of the room at that time only needed raising on an average about 16° to bring it up to 60°, it will be seen how futile a comparison in this way became. When allowance was made for the variation, some most extraordinary comparative results were obtained. Notwithstanding this disappointment, the labour expended was not altogether wasted; and though taken several months before, they confirm to some extent the conclusions arrived at by the Coal Smoke Abatement Commission when they said: "A properly constructed gas-stove, *with a flue sufficiently large to carry away the products of combustion*, is quite as satisfactory as a coal-fire from the hygienic standpoint, does not in any way vitiate the air of the room, nor does it produce any abnormal drying effect as is popularly supposed." [The italics in this quotation are advisedly introduced.] The Coal Smoke Abatement Commission, as has already been pointed out, operated upon stoves which were connected to a flue 9 inches in diameter and 68 feet long. The length of the flue to which the stoves in the tests here recorded discharged their products was but 22 feet long, and with the exception of the galvanized portion shown in fig. 4, was 16 inches by 12 inches in area. These were hardly domestic conditions; and with the tremendous exhaust on the stove outlet, no doubt practically the whole of the products from many of the stoves tested passed up the flue. A properly constructed gas-stove, under such conditions, would not necessarily be properly constructed for ordinary usage. Still, though in some of the earlier tests taken, a portion of the products bye-passed, the rapid changing of the air contents of the room kept the air satisfactory.

Columns 12, 13, and 14 of Table No. 5 bear upon this subject. Column 12 was compiled from the area of the flue (fig. 4) and the rate of flow as recorded by the anemometer. Column 14 was obtained from the results of analyses made each day at 3 p.m., or five hours after lighting up. During four hours two persons remained in the room, and jointly produced carbonic acid at the rate of 6 parts in 10,000 per hour; while the ingoing air contained 3·5 parts in 10,000. The room had double doors padded at the top and sides; the window was double cased; the only outlet was the chimney shaft; and the only inlet the Tobin's tube. When the consumption was fairly proportioned to the size of the room, as in the first four tests, the average analysis was 9·5 parts of carbonic acid per 10,000. When the consumption was greatly in excess of requirements, the average was 15·89 parts per 10,000. Column 13 shows that the air was never changed less than twice within the hour. Unlike the Coal Smoke Abatement Commission tests, however, the air was not caused to pass through the comparatively small outlet flue of the stove at a rapid rate, thereby diminishing the radiation efficiency, but chiefly passed direct from the room to the bottom of the chimney.

*Humidity.*—Turning to humidity, such results as were obtained in this investigation showed that the proportioning of the fire has an important—probably the most important

—bearing on the subject. The average of the first four tests taken of the same fire on different days in January, 1906, and summarized from Table No. 5, gives the following results:—

| | |
|---|---|
| Calorific value of gas . . . . . | 564 B.Th.U. gross. |
| Average consumption per hour . . | 13·92 cubic feet. |
| Temperature at 10 a.m. . . . . | 46·25 degrees Fahr. |
| „ „ 4 p.m. . . . . | 60·5 „ „ |
| Humidity at 10 a.m. . . . . | 83·5 |
| „ „ 4 p.m. . . . . | 84·5 |

The testing room measured 2030 cubic feet (fig. 9), and the fire was of the fire-clay ball type, with flue extended to chimney. The humidity was ascertained by wet and dry bulb thermometers; the readings being corrected for dew-point by Glaisher's tables. These results may be contrasted with those obtained in the next eight tests, embracing four fires, all of much larger consumption, and the average of which worked out as follows:—

| | |
|---|---|
| Calorific value of gas . . . . . | 575 B.Th.U. gross. |
| Consumption per hour . . . . . | 35·45 cubic feet. |
| Temperature at 10 a.m. . . . . | 48·8 degrees Fahr. |
| „ „ 4 p.m. . . . . | 71·5 „ „ |
| Humidity at 10 a.m. . . . . | 9·1 |
| „ „ 4 p.m. . . . . | 69·9 |

It is unfortunate that time has not permitted the writer to again turn to this portion of the subject. So far as the results go, however, they indicate that if the temperature of a gas-heated room is properly looked after, complaints of dryness are unlikely; and the public cannot be impressed too much with the importance of this. It is essential, too, that as much of the heating as possible be done by radiation, which, while warming the objects, keeps the air cool.

*Conclusion.*—The difficulties that beset one in entering upon a study of this subject were great; but to break off at such an apparently unsatisfactory stage is infinitely greater. The methods adopted for testing radiation, flue heat, and heated air tests are described in detail; so that it will be easy to follow the lines pursued. Combined they form, in the author's opinion, the nucleus from which ultimately perfectly satisfactory means of comparison will be evolved. The factors which have their bearing upon gas heating appear to be legion. Before gas-fires become "household deeds," many problems await, and demand, solution. As an Appendix to this paper, certain "Suggestions for Research" are given. To an individual, the list may appear an impossible one; but to an Institution with a membership roll of over 800, they should be but the clarion cry that leads to victory. Mr. Bond, of Southport, made an excellent suggestion when we were discussing the matter. He said that if any considerable number of members were to each take up one special aspect of the question under expert guidance and advice, much valuable data would result. A great deal would depend on the extent of expert guidance we could secure; but subject to this, it is quite practicable. "Rome was not built in a day." It is twelve years since the subject last came before the Institution. At such a rate of progression, Rome would, it is to be feared, have still been incomplete. If we are all determined to see that gaseous fuel plays its proper part in the purification of the atmosphere of not only towns and cities but of villages, the milestones of future progress will bear a more legible inscription than is writ upon those that are passed.

## Appendix.

### Gas-Fires—Suggestions for Research.

1.—To determine the qualities best desired in gas-fires for
- (*a*) Living rooms.
- (*b*) Shops, workrooms, and offices.
- (*c*) Public buildings, &c.,

having regard to hygiene and economy.

2.—To settle under what conditions flueless stoves may with safety be recommended for use.

3.—To determine the tests to be applied to all varieties of gas-fires. To indicate such tests as may be applied by the officials of gas undertakings.

4.—To evolve formula for guidance in specifying correct sizes of stoves for rooms of various kinds having regard to
- (*a*) Height, furnishings, and aspect.
- (*b*) Ventilation.

5.—To investigate the effect of dust on the products of combustion and the efficiency of gas-fires.

6.—Where gas-fires are connected to flues, to ascertain the best methods of fixing to ensure that ventilation is still adequate, and that products of combustion pass direct from the stove to the flue.

7.—To determine the relative efficiency of the following general types of stoves:—
- (*a*) Flueless stoves.
- (*b*) Gas-fire stoves, with or without waste heat chambers.
- (*c*) Gas-fires (baskets).

8.—To ascertain and determine the effect of varying pressures on all types of stoves.

9.—To investigate the merits of compression of gas, or air, or both, and to make research into flame temperature as applied to gas-fires.

10.—To ascertain the effect of differential prices for gas used for the heating of rooms.

### Discussion.

The President said all must be agreed that they were much indebted to Mr. Brearley for a most interesting and valuable paper.

Mr. R. G. Shadbolt (Grantham) remarked at the outset that he wished to compliment Mr. Brearley upon the very painstaking contribution which he had placed before the members. It was not a mere mass of material flung at their heads, but a marked instance of valuable facts carefully ascertained, systematically marshalled, and results clearly defined. These were the prominent features of the paper. Those who had experimented most would value them very highly. The popularization of gas-fires was, in more senses than one, a burning question with them all. Whatever means were employed, they should endeavour to get a close grip of the subject, in order that they might serve the public as they felt they ought to be served. Undoubtedly, they must trust to the commercial department for bringing in business. Still it was a fundamental necessity that they should ground themselves in, and become thoroughly acquainted with, the principles underlying the regulation of the action of gas-fires. They had an example of this in the paper—namely, the consumers who were secured entirely through canvassing, quite apart from the value and efficiency of the fires. But, after all, canvassing was only a temporary expedient, and would continue to be so unless they could prescribe the various conditions under which gas-fires could be used. The outstanding features of the paper were the comparative radiation values, the convection values, and the flue waste, as determined by the author. The radiation values were most interesting and instructive; but there came in the great difficulty of converting galvanometer readings into absolute radiant duty. Though it was interesting to compare fire A with fire B, on the other hand it brought them little nearer the idea of the proportion of the heat generated to that given forth in radiant form. He had endeavoured to get at this roughly; and no doubt others had done the same. If they took as an example a gas-fire that showed the highest amount and another showing the smallest amount of fuel heat waste, and took the ratio of the two one to the other, and compared it with the radiation value given in Table I. in the paper, a great discrepancy would be found. If, for instance, they took the highest flue waste *plus* the convection duty of that particular fire, it left a balance to radiation of 36·7 per cent. of the total heat. In the same way, taking the minimum flue waste and convection value, it left a balance to radiation of 55·5 per cent. This was a ratio of 1 : 1·5. If they traced this fire through, and compared the duties of the same test in Table I., it would be found that, instead of it being as 1 : 1·5, it was as 1 : 1·29, but in the opposite direction. This was an instance of the perplexing difficulties which investigators had to face in the future in endeavouring to explain away these discrepancies. It was a difference which would not really be anticipated. In the same way, if the convection duty was taken as the basis, the same thing would be found; only in this particular case the differences were in the same direction. Admirable as this method was of ascertaining the radiation duty of a fire, it did, as Mr. Brearley had said, indicate the radiation duty at the maximum point only—the mean radiation value not being obtained by the thermopile. The difference was probably to be accounted for by two factors—first, the quantity of radiation heat which became convected, and the difference in the mean radiation duties, which was not by this means obtainable. With the best will and ability in the world, it was not everyone who had the opportunity of under-

taking such exhaustive tests as these; and the ordinary gas manager was called upon to prescribe for his own particular conditions. A winter or two ago, he was puzzled to answer a consumer who said he had a room of a certain size, and asked what kind of gas-fire he (Mr. Shadbolt) would recommend. It took him all the winter to answer the question. He used his own Board-room, of 3000 cubic feet capacity, for making the test that Mr. Brearley so rightly deprecated. He took two maximum and two minimum thermometers, and placed one 5 ft. 6 in. from the fire and 2 feet from the floor, and the other about 11 ft. 6 in. from the fire and some 5 ft. 6 in. from the floor, on the wall. The air inlets were two windows from the street and the staircase. Outside the windows, he placed another maximum thermometer; and a minimum thermometer outside the door. Taking the mean of these two thermometers, and that of the two in the room, he arrived at a comparative basis which met the case, and enabled him to answer the consumer's question. He found that he got an average of condensation of 1·15° per cubic foot of gas per hour in the room. Taking fires of various kinds, the efficiency came down from 1·08° to 0·65°. He had a remarkable instance of one fire which gave 0·76° per cubic foot per hour; but when it was fitted with an adjustable burner, the efficiency rose from 0·76° to 1·08°, which was very nearly that of the condenser. These were instances of the difficulties under which they worked; and, as indicating a means of meeting them, Mr. Brearley's paper would be all the more valuable. To his mind, the revelation of the paper was the percentage of the products of combustion bye-passing in front of the fire, as shown in Table III. It was a complete revelation to imagine that the smallest proportion of products bye-passing in front of the fire was 22·3 per cent., ranging up to 50·8 per cent. What the stove-makers were doing to have this proportion of flue outlet and area of canopy he could not imagine. It was to him a remarkable statement. One would certainly have expected a much smaller loss than this. It only went to prove, or helped to prove, the contention of Mr. Brearley as to there being a necessity for having a sufficient vent in the chimney in addition to that of the flue outlet simply. He had in his own sitting-room at Grantham an illustration of the effect of a fault in the chimney. When the wind was in a certain direction, they got puffs sufficient to pull the air away from the burner—resulting in a luminous flame every time a puff came. This went to show that the pull should be taken off a gas-fire as much as possible. Mr. Brearley certainly deserved their praise for the very persistent and painstaking way in which he had conducted the carbonic acid test. With respect to carbonic acid, they had a standard to which they could work, and which they could compare with their own tests. Taking the average of Table V., it was seen that the air was changed three times in an hour, with 1 per cent. of added carbonic acid, in a room containing 2030 cubic feet. Of course, any other room duly proportioned would give just the same results. There were many things that they, as gasmen, had to do, and would still continue to do, against what they considered as their own better judgment. It very often happened that a consumer would insist on having something which they knew was not altogether the best thing. For instance, let them take the popularity of gas-steam radiators. For several years he objected to supply them; but they found people obtained them elsewhere, so they were compelled to take them up. He had been trying to ascertain the vitiation of the atmosphere caused by them under normal conditions. He had had tests made for him by a chemist with a steam-radiator. He first tried it in a school-room of 4800 cubic feet capacity. The room was closed, and not used at the time for two days and nights. Two gallon jars were placed on a table 3 feet from the floor. This test showed, after the room had been kept closed for 48 hours, that the air contained 0·8 per cent. of carbonic acid, with a slight trace of sulphurous oxide. Then they made a test extending over 24 hours, starting at midday with a room in use in the ordinary way by students going in and out; and instead of 0·8 per cent. they had 0·15 per cent. of carbonic acid, which was within a second decimal of the amount Mr. Brearley showed. So that it would be seen that, though it looked very formidable in the first instance, under actual working conditions it was not so. The time at his disposal was too limited to allow of his touching upon the importance of proportioning fires to their environment, and the effect upon humidity. He would therefore conclude by offering his small tribute of acknowledgment of the immense amount of work the paper must have involved on the part of Mr. Brearley, to whom his personal thanks, as well as those of all the members, were due for the splendid start he had given to future investigators.

Professor Lewes said Mr. Brearley had said such pretty things about him at the commencement of his paper, that he felt he must heartily thank him for the large amount of work he had brought to bear on the subject dealt with. There were one or two things which he thought were deserving of a considerable amount of attention. In the first place, there was the point to which Mr. Shadbolt had referred, with regard to flueless stoves. He (Professor Lewes) knew he had brought down upon himself a good deal of ill-feeling, owing to his opposition to these stoves; but he could assure the meeting that flueless stoves had been their worst enemies. They heated the air of the room; but when they did that they made the air hungry for moisture, and then they at once had the consumer kicking out the gas-stoves because he said they dried the air of rooms. It was the flueless stove that started the outcry against gas-fires, which had been one of the most serious things they had to overcome. The real secret of the popularity of the flueless stove was the amount of heat that was translated from the gas into the air of the room. When they had a flueless gas-stove, it did not matter whether it was called a steam-radiator or a regenerative burner—the whole of the heat went into the room; and they might just as well have a plain bunsen burner at the cost of 10d., as the most elaborate flueless stove. It would be found that, under these conditions, they not only had the whole of the products of combustion, but very little radiant heat. They had hot air, and this air was sucking up the moisture from everybody and everything it could get it from; and this gave rise to a considerable amount of discomfort. Mr. Shadbolt had given them an instance, when he locked up a steam-radiator in a schoolroom for 24 hours; and he stated that at the end of that period there was only 0·8 per cent. of carbon dioxide in the room. But, after all, this was exactly 25 times as much as the normal quantity; and it was some 12½ per cent. above the sanitary limit. This was something to go on with. There was not the slightest doubt that heating in this way was distinctly injurious to health, and likely to give rise to prejudice against gas-stoves. This, to his mind, had always been the important factor of the attack against the flueless stove. The basis of the popularity of the stove was this: Supposing they had a room of a defined size, and, instead of taking the radiant heat coming from the stove, attempted to determine how many degrees above the ordinary gas-stove it would give out. Taking a room of 3000 cubic feet capacity, if they wanted to heat it up to 10° above the outside temperature, by using a flueless gas-stove, this could be done with a consumption of 14 cubic feet of gas an hour. With a pure radiating stove, fully carrying off the products of combustion, they would use 40 cubic feet an hour; and by employing a gas-stove of an intermediate pattern, which practically gave less radiant heat, the same amount of heating could be obtained with from 18 to 30 cubic feet an hour. There they had three distinct grades; and, from a hygienic point of view, the best was where the stove was heating the room by radiant heat, using 40 cubic feet an hour. Adopting an intermediate form, which was better because it took away all the products of combustion, the consumption went down to an average of 20 cubic feet an hour. But, adopting the flueless stove, it could be done, as he had said, with a consumption of 14 cubic feet; and in this, in his opinion, lay the secret of the popularity of the stove. Returning to Mr. Brearley's paper, there were one or two small questions he would like to ask him. In the first place, he did not think the author had given them the method of determining the carbon dioxide; and, in the figure showing the bye-passing round the front of the grate, he noticed that the air supplied in front showed 0·099 of carbon dioxide. This was three times as great a quantity as was to be found in average air; and he should like to know how this was determined. Another point brought out in the paper was the fixing of the fuel-grate into the backing of the stove, so as not to allow any surplus air to be drawn in, causing a decrease in circulation. As they did this, they must draw the air close to the grate, and thus reduce the radiant heat from it. The point he should like to make was as to the importance of this in ventilation. They could really use the flue of a gas-stove in exactly the same way that they could utilize the injector of a bunsen burner. The injector could be employed at any point they pleased; so that they could, if they liked, use

their fuel as it came from the smaller stove into a suction chamber, and draw the air into a chamber in front of the mantelpiece. They might, however, take it at a higher point, and so form a very effective method of ventilation at the top of the room. These methods, of course, necessitated structural alterations, and could only be adopted where they had a house specially built, and a gas-fire specially adapted to the house. Nevertheless, this was a point which it might be well to bear in mind. Mr. Brearley appeared to have been very fortunate with regard to his percentage of carbon monoxide. He (Professor Lewes) could assure him that it would be found, in very many of the ordinary forms of stove, that if they used it as the consumer did, perhaps within a quarter-of-an-hour, the carbon monoxide could be lit as it came out at the back. In conclusion, he desired again to thank Mr. Brearley most heartily for his paper; and he could only wish there were many others who would do work of the same character. It was only by building up masses of data such as those in the paper that they were able to arrive at factors which were of the very greatest importance in gas-stove manufacture.

Mr. H. J. Yates (the Managing-Director of Messrs. John Wright and Co.), having thanked the President for the opportunity afforded him of being present to hear the paper read, said stove makers were very much indebted to Mr. Brearley for what he had done, and if they did not take advantage of some of his tests, they would—to put it in strong language—be fools. After the able way in which Mr. Shadbolt and Professor Lewes had dealt with some of the details of the paper, he proposed to discuss it on broader lines. He thought the key-note of excessive gas pressure had been sounded on the previous day, when uniform pressure was advocated. If this could be obtained in a house, a burner could be constructed that would work far better than otherwise. With regard to the question of the flue, this varied very much. In some houses there was no pull at all on the chimney, while in others it was speeded. If they had a constant pull in the chimney, there would not be so many heat products lost up the flue. Some years ago, he had experimented with an automatic air-inlet placed in the flue above the fire. He found that when the fire was first lighted, a pull was created; then it ceased, and the products came into the room. Afterwards he experimented with an adjustable inlet. But he found that if it was put into an ordinary fire, it was always left open when it ought to be shut, and *vice versâ;* and consequently the fire was thought to be of faulty construction. There was one point in the paper that required consideration, and that was the construction of the flame. If they over-oxidized the flame, they got too much heat at the nozzle of the burner; but it did not heat the fuel well. Then there was a great deal to be said in regard to the composition of the fuel. He had been experimenting on this point, but there was still much to be learnt with regard to it and to the brick at the back of the fire. He was very interested in Mr. Brearley's remarks about the thermopile he used. Then, again, the gas and air adjuster was a good thing. As to the humidity in a room, if there was good ventilation and they did not overheat the room, they would not suffer from want of humidity. A flueless stove without good ventilation dried the air very much. With gas-steam radiators, of which there were a large number now on sale, there would not be condensation; and provided the air of the room was changed often enough, he could not see any harm in using them. He had been consulted by a hospital authority as to the advisability of putting gas-steam radiators into the wards. He strongly advised them not to do it; but they had done so, and had reported favourably upon them. He had also been asked to advise as to putting radiators in the operating theatre of another hospital. In this case he wrote a very strong letter; but nevertheless radiators were put in, and he believed they were satisfactory. He only mentioned these things to show how stupid people were. Certain stoves were designed for certain work; and if they were put to do other work, and did not give satisfaction, it was the people's own fault. A gas radiator was an admirable thing for heating a shop or a hall. Mr. Brearley said the heat was lost very quickly; but he (Mr. Yates) could not agree with him altogether in this. In a properly constructed radiator, most of the heat was obtained by convection; but it was distributed well round the room. It was a very cheap form of heating, because, if the cost was worked out, it would be found roughly that the room could be heated with the same quantity of gas that it took to light it. People did not grumble at their incandescent burners; but they must bear in mind that the combustion in an incandescent burner could not be so perfect as it was in a properly constructed radiator. In this appliance the gas was free from any possibility of impinging on anything; whereas in a mantle there was a great draught the whole time the burner was in use, and the combustion was upset. With two rooms of equal size, one lighted with incandescent burners and the other heated with a gas-steam radiator, it would be found that the air was better in the latter case.

Mr. Walter Grafton (Beckton) said Mr. Shadbolt had anticipated him in a great deal that he wished to say. In the course of his paper Mr. Brearley said: "It does not follow, however, as has been assumed by others, that a greater duty may be obtained from gas-fires by the application of high pressure." He (Mr. Grafton) would rather take the passage a little farther down: "The duty indicated by the thermopile and galvanometer is practically the same in both." But, referring to the paper, he did not show this. In Table I., the whole of the tests were indicated by letters; and they showed a marked increase in the radiating effect by increasing the pressure from $\frac{1}{2}$ inch to $2\frac{1}{2}$ inches. This was something that was well worthy of their attention; showing that those who were supplying gas at 10-10ths pressure to consumers were not courting success. The figures were not regular or uniform; but they showed, from beginning to end, an increase, and this was greatest where the least amount of gas was consumed. His figures (percentages) were as follows: "D, 31; $D^2$, 16; E, 25; $E^2$, 28; F, 16; G, 32; $G^1$, 15; H, 28; $H^1$, 15; $H^2$, 52; $H^3$, 58; and J, 16"—giving a mean, from the beginning to the end of his table, of 27 per cent. due to increasing the pressure from 10-10ths to 25-10ths. He did not know what it would have been if he had gone up to 40-10ths. He should like it to be noticed that the volume of gas consumed was not the cause of this marked effect; nor did the heating value of the gas itself account for it. Passing on to another matter, Mr. Brearley used a calorimeter giving only 90 per cent., and then took his results from this. He (Mr. Grafton) did not know where he had made any correction for the other 10 per cent.

Mr. Brearley: That is explained in the paper.

Mr. Grafton said, on the point Professor Lewes had referred to—viz., placing the fuel-stove close up to the range—the draught was increased, since there was only a small inlet; and, whether or not the fire was going, there was always a certain pull up the chimney. The amount of heat carried away was shown to be some 25 per cent. When standing away from the flue of the chimney, the radiant heat was allowed to pass into the room more easily. With regard to the carbonic oxide test, he was rather sorry the figures had been given, because they tended to prejudice the use of gas-fires. His experience was that carbonic oxide was not given off into the room when there was proper control over the chimney. Such statements as these prevented people from having gas-fires. He had one in his own bedroom, and he could discover no trace of carbonic oxide, because he used a damper on his burner, and therefore did not allow more air to pass to the fire than was just sufficient to bring about complete combustion. If they overdid it, they might get some of the ill-effects of carbon monoxide. When speaking of the presence of this gas, he did not notice that anything had been stated about the occupants of the room—as to whether or not they were smokers. This would greatly affect the case. A certain proportion of carbon monoxide was disengaged from tobacco—much more than from a gas-fire properly connected; and therefore it might be that it came from the source named. Later on in his paper, Mr. Brearley came to deal with the question of humidity. Professor Lewes had referred to this, but had not touched upon the point he (Mr. Grafton) wished to mention. With regard to the test described in the paper, he should like to know whether it was taken on a wet or a foggy day, because this might affect the result. It made all the difference whether the air was dry or moist. When it happened to be moist, one felt chilly; and the state of the air very much affected the case.

Mr. H. M. Thornton (the Managing-Director of the Richmond Gas Stove and Meter Company, Limited) also wished to thank the President for his courtesy in inviting him to be present to hear the paper read, and in allowing him to take part in the discussion. After the criticisms of Mr. Shadbolt and Professor Lewes, it did not behove him to make any further remarks on the paper generally; and he wished to

say that the manufacturers must of necessity largely benefit by such a communication as they had just heard. Mr. Brearley had gone into the matter with great labour, and had devoted much thought to it. If the stove makers could have the opportunity of obtaining his services in a regular way, they would be only too pleased to avail themselves of them. The paper showed beyond doubt that there was the greatest possible need in the gas industry at the present day for nearer and more complete co-operation with the manufacturers of this country than there had been in the past. If the result of the paper was to provide means of investigation into a subject which bristled with difficulties, he felt sure that he would not be saying anything out of place if he suggested that the co-operation of the manufacturers of gas-stoves should be asked; and he was quite sure, if this were done, it would be given by them with enthusiasm. Gas engineers would have from them data which they had in their possession, and which could not but be of advantage to the gas world at large.

Mr. T. Glover (Norwich) said they would not be doing their duty if they forgot the services rendered to the industry in times past by the late Mr. Thomas Fletcher. One very interesting fact, among many others, that he brought out was that the sensation of dry atmosphere in a room was not due to the gas-fire as such, but to the use of imperfect gas-fires, which allowed small quantities of the products of combustion to escape into the room; and he thought Mr. Fletcher found that it was due particularly to a small proportion of carbon monoxide. This was a fact which they had to bear in mind, and one which they should make clear to the consumers when they displayed any serious prejudice against the use of gas-fires. He was glad to say this prejudice was now being very rapidly overcome. In his own city of 120,000 inhabitants, with about 25,000 houses, he had fixed in a season as many as 600 gas-fires, chiefly of the pure radiating form. This was the kind they should advocate wherever possible. The best results were obtained from a pure radiating fire, because it was one in which they did not depend upon convected heat. It was fixed with a canopy with a moderate chimney draught, so that any pull from the chimney did not draw the radiating material. They had also found very great benefit by controlling the pressure to the fire by a volumetric governor. Since they had begun this practice, they had had fewer complaints and fewer stoves returned to them. It was a good thing to fix fires which would remain out, and not be sent back after the first half-year's use. Though Norwich gas was not by any means cheap, they had given very great satisfaction to their consumers by advocating the use of fires made on rational lines, and fixed very carefully from the point of view of draught and like matters. He thought Professor Lewes's criticism of the flueless stove was far too sweeping. No doubt, on matters of principle, they were quite as high-principled as Professor Lewes; but they had to take things as they were, and do the best they could. Possibly the criticism applied to the tubular stove, with a fire attached to it, fixed in a closed compartment. He had no doubt that this fire was responsible for turning out a certain amount of carbon monoxide, and for poisoning the atmosphere of closed rooms. Some time ago, he was in Messrs. Maple's large establishment in London, where he saw these stoves fixed all about the place. He spoke about them to someone there, who referred in the very highest terms to their usefulness. He had fixed these stoves, with excellent results, in shops in Norwich. At the beginning of each winter, they brought them all in and cleaned them. They rearranged the fuel, and fixed them wherever there was plenty of ventilation. He disagreed entirely with Professor Lewes in his statement that they might just as well have a bunsen burner. They had the local heating that was so desirable —something that they could feel; and it was not true to say that they might burn gas in the open and get equally good results. Though it was not a perfect form of heating, it was one which they might fix up on certain conditions without feeling that they deserved to be sent to prison. The gas-steam radiator was, he thought, a great improvement. As had been pointed out, the bunsen flames were burnt quite apart from the surface to be heated. They did not impinge upon anything, and perfect combustion was obtained. If this was the case, what did 1 per cent. or 2 per cent. of carbonic acid matter? In mineral water manufacture, they had an exceptionally high percentage of it without any detriment to the health of the employees. It was not a question of the increase of carbonic acid that made the atmosphere bad—it was the bacteriological side which had to be considered; and he did not think that steam radiators came under the sweeping condemnation that had been placed upon them by Professor Lewes. He thought great improvement might be made in the future on what Mr. Brearley called "fuel," but which he thought ought to be spoken of as radiating material. Mr. Brearley had rightly condemned the word "asbestos." They knew that it was wrong. But the clay balls in a fire were not fuel—they were radiating material; and he thought great improvement might be made in the material to give the idea of warmth as well as the real thing. He did not suppose they were going to make any great discovery with regard to radiating material such as had been made for converting the heat of a bunsen flame into light; but he did think they might give the sensation of warmth by appearance by a material that would not heat up to a dull red, as in a gas-fire, but to a bright orange, or something even higher, and thus present a much more cheerful appearance. As he had said, he thought there was great room for improvement in this direction.

Mr. F. W. Goodenough (London) wished to associate himself with what had been said by other speakers with regard to the value of Mr. Brearley's paper, and to the enormous care and time he had devoted to the subject. He should also like to thank Mr. Shadbolt for what he might call his supplementary paper, which was a most valuable contribution. As the "criminal" who was responsible for fixing the flueless stoves Mr. Glover had seen at Messrs. Maple's establishment, he would join in the protest which had been made against Professor Lewes's sweeping condemnation of that type of heater. Sometimes it was shown that practice was better than theory; and the stoves at the establishment named were a particularly good illustration of the truth of this. He had been instrumental in having the stoves fixed, in consequence of having been nearly frozen to death when spending a morning there with his wife selecting furniture. He thought that Professor Lewes would agree with him that it was better to be warm, and to breath a very minutely increased and imperceptible percentage of carbonic acid gas, than to contract pneumonia. At Messrs. Maple's establishment, there were no means of fitting fireplaces; and therefore it really resolved itself into a question of whether they should use flueless stoves or electric radiators. As a matter of fact, the firm sold electric radiators, but themselves used flueless gas-stoves. One of his customers went into Messrs. Maple's establishment, and, while he was being canvassed by the shopman to buy an electric radiator, he happened to catch sight of the gas-stove. He pointed out that they were using gas, and asked why it was. The man replied that he supposed gas was cheaper. Consequently the customer said he would also have gas. In his (Mr. Goodenough's) opinion, it was absolutely impossible, and altogether misleading, to endeavour to lay down any definite rule as to how to fix a gas-stove. His own experience had been that local conditions varied so greatly that every case practically had to be decided upon its own merits. Mr. Brearley had spoken of it being altogether wrong to place a gas-fire close to the grate, filling up the space round the stove-pipe with iron or asbestos sheeting, because the heating efficiency of the stove was thereby reduced. There were conditions in which it was absolutely necessary to do this, in order to increase the efficiency of the stove, because they might have a powerful up-draught in the chimney. They might have to reduce the flue diameter in order to moderate the draught. With every stove they fixed, they had to study the local conditions; and he was perfectly certain that, in order to overcome the public prejudice—happily, a rapidly dying prejudice—against gas-fires, it was necessary to exercise the greatest care and intelligence in fixing the stoves, and also in inspecting them after they had been fixed, to make sure that they were working satisfactorily, and not giving off 50 per cent. of the products into the room, which was a figure that had utterly astonished him, and was certainly not a condition experienced in common practice. When a stove was being tested after lighting by holding a taper at the very top of the fire opening, the flame from the taper was nearly always drawn in, instead of there being any of the products coming out. If he found any of his staff fitting up stoves from which the products came out to the extent of 50 per cent. into the room, there would be trouble. Then, again, periodical inspection of gas-fires by the gas company was necessary. His Company had recently instituted the system, and he believed that it promised very great things in the future.

The public did not know how a gas-fire should be treated. One friend of his used to stir his fire-clay up with the poker to make a brighter fire (!); and consequently the burners very soon became choked. If gas-stoves were not occasionally overhauled by a man who understood them, they would give trouble. In his Company, they attached so much importance to the fixing and adjustment of gas-fires that their "Book of Rules" contained several pages of directions for fitting stoves and for remedying defects when found. Mr. Brearley said he thought the fixing of a separate governor could be dispensed with, by the fire being fitted with a gas and air adjustment. He (Mr. Goodenough) did not agree with him; because, while the gas and air adjuster was a useful thing for the fitter to treat the fire with, according to the local circumstances, it did not guard against fluctuations of pressure. He considered the system that Mr. Glover was adopting, and which he had adopted, of fixing a volumetric governor on every fire, would lead to satisfactory results. Mr. Wilson had asked him (when speaking) to put one question to Mr. Brearley—as to whether the use of the calorimeter on the flue in his tests would not retard the draught, and so cause products to be passed into the room.

Mr. BREARLEY, in reply, said he was afraid he should be unable, in the time at his disposal, to deal with all the points raised in the discussion. Mr. Shadbolt and other speakers had been very complimentary to him with regard to the amount of work contained in the paper. For his part, he should feel amply compensated for what he had done if it caused anyone else to continue or initiate investigation into gaseous heating on these or other lines. What was required was greater concentration of effort upon this problem. To him the work had been much like ploughing an unploughed field, so far as the particular methods of testing which he had recorded were concerned. But if the ploughing of the field resulted in other husbandmen entering it, and bringing forth a more satisfactory crop of gas-fires, then his paper would not have been prepared in vain. The superficial observer might easily come to the conclusion that as there were three forms in which the heat was given off from a gas-fire—viz., radiation, convection, and waste heat—the last two being known, one could arrive at the radiation by the difference between the other two. But if they followed more closely the methods described in his paper, they would find that he made no such claim. Therefore, the ratios which Mr. Shadbolt had quoted were possible, and in no way nullified by any of the figures he had put forward. For instance, when measuring the convection heat, they also measured some of the radiation. They were bound to do so, because the rays of heat would strike the sides of the hood, and by the time they reached the top they would be transferred into the air. He only claimed for the apparatus a method of comparative testing, not a method of separating convection from radiation. He was very pleased that they had had the advantage of having present the representatives of two manufacturing firms. To his mind, the matter had been left too much to the manufacturers; and while it was certainly to their benefit that gas-fires should give satisfaction, if they did not do so, it was the gas engineer or his representative who had to face the discordant music. He was very pleased to hear that a coalition might possibly be effected between the manufacturers and the gas engineers, for the purpose of going forward with research into this subject. He was going to suggest, apart altogether from Mr. Thornton's remarks, that, seeing that they were initiating some researches in connection with one of the Universities, possibly the stove makers would not object to join in the expense, as they certainly would join in the benefit derived. This research would cost a considerable amount of money; and if the Council of the Institution decided upon it, possibly through the Society of British Gas Industries (in which he understood fifteen stove firms were enrolled), they might, by combination with them, work in unison. The time at his disposal was too limited to deal with all Mr. Shadbolt's figures. He was somewhat surprised at the low quantity of gas consumed for 1° rise in temperature. Mr. Shadbolt had not given his figure for the carbonic acid in the room obtained in his tests. Professor Lewes had asked as to the method adopted for testing for carbonic acid. In answer, he would refer him to the third column of the Supplementary Notes to Table III. He used Wanklyn's bottle with baryta water, and sampled the air 3 feet from the fire. He ascertained by the smoke test the direction in which the air from the fire was coming, and there took his sample. He found that somewhere between the Tobin tube and the gas-fire was the best place to take the sample. No doubt other members would be inclined to make some research as to the exact period when the generation of carbon monoxide took place. Mr. Walter Grafton had spoken of some apparent discrepancies in his statement as to high pressure adapted to gas-fires. Speaking of high pressure in the body of the paper, he meant something much higher than 2 to 3 inches. He was thinking of 9 to 10 inches; and though in his paper there was a rise of duty between the extreme of 10-10ths and 25-10ths, he was quite satisfied that they would get a relative rise if they increased the pressure right up to 10 inches. He merely threw out this remark in his paper to provoke some other member to make research upon high pressures as adapted to gas-fires. Mr. Grafton had also spoken about the calorimeter giving only 90 per cent. In the paper, he explained how the remaining 10 per cent. was accounted for by the curve in Diagram 5. At the present time he might reply to Mr. Goodenough's remarks with respect to the calorimeter, and say that he believed, so far from reducing the draught of the flue-pipe, it had a tendency to increase it, because immediately the hot gas entered the bottom of the calorimeter there would be a reduction of temperature in the gases, and the vacuum which would be created by it must be filled, and it would be filled by a greater ratio of heated products from the gas-fire. So that, so far from retarding the draught, the calorimeter would improve it. In regard to the governors, he did not say that governors could be altogether dispensed with, but only that the gas and air adjuster enabled the governors to be dispensed with within certain limits. Unless regular pressure at regular hours of the day were kept, the best thing to do was to fix a governor at once with gas-fires; but if the pressures were regular, they could fix the gas and air adjuster so as to dispense with the governor. He did not think there was a large percentage of cases in which this could be done, because the pressures from daytime to evening varied considerably in nearly all districts; and if the adjuster was fixed to suit the day pressure, it was not suitable for the night pressure, and to this extent it did not quite satisfy the regulation of the gas. He must thank Mr. Goodenough for his remarks; and he would ask him, on behalf of the Institution, if he had any objection to publishing the "Book of Rules" given to his fitters. He thought if they had these rules they could be adopted with advantage all over the country. He did not consider that this was like asking his Company to edit advertising magazines for them; but he thought it was a point on which Mr. Goodenough might be able to oblige them.

## INCANDESCENT GAS LIGHTING, WITH SPECIAL REFERENCE TO INVERTED BURNERS.

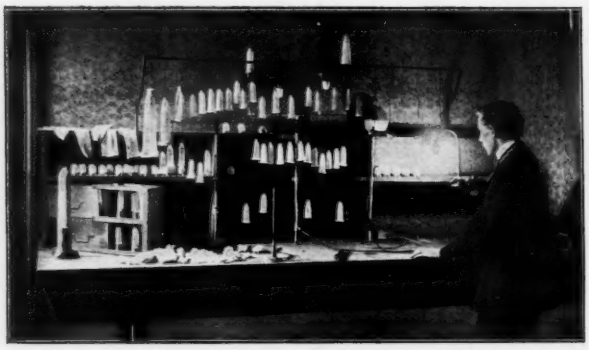
By HAROLD E. COPP, of West Bromwich.

Though little more than twenty years have elapsed since Welsbach's great invention began to be practically applied, incandescent lighting has developed with such rapidity, and has attained such a remarkable degree of popularity, that the subject must now be regarded as one of the most important connected with the gas industry. It is therefore with no small amount of diffidence that the author ventures to approach such a subject—realizing, as he does, the impossibility of dealing completely with its many phases within the limits of an ordinary paper. There are, however, certain features which, perhaps, appeal more especially to the gas engineer; and though upon many of them there will doubtless be great variation of opinion, the author would, at the outset, ask the members to accept his assurance that in the collection of information, and in the conducting of tests and experiments for the purposes of this paper, he has observed the strictest impartiality.

On looking through the extracts from patent specifications, published from time to time by the technical journals, it will be observed that gas engineers have contributed their full share of inventions relating to the manufacture and distribution; and as the result of much ingenuity and most careful investigation, a standard burner has been produced for the testing of all grades of gas. Yet it is singular that comparatively few specifications relating to the practical use of gas for lighting purposes bear the names of members of this profession. The subject, however, judging from the extraordinary number of inventions relating to it, seems to exercise a great fascination for some people. Unfortunately,

a large proportion of the inventions appear to be superfluous; and the process of attempting to discriminate between those which are likely to be useful and those which are not, is necessarily a long and tedious one. It will not be denied that numbers of incandescent burners have been placed on the market which must have had an injurious effect upon the industry; nevertheless, the attention which is being given to the matter by writers and inventors is an extremely hopeful sign, and will doubtless be productive of beneficial results.

The charts showing curves of the efficiency of a few of the burners most popular in the United Kingdom indicate great variations, and prove how necessary it is that those who are responsible for the welfare of the industry should be in a position to recommend to consumers the best burners and mantles for the particular purpose for which they are required. There are four ways by which still further progress may be made: Firstly, by attention to the conditions

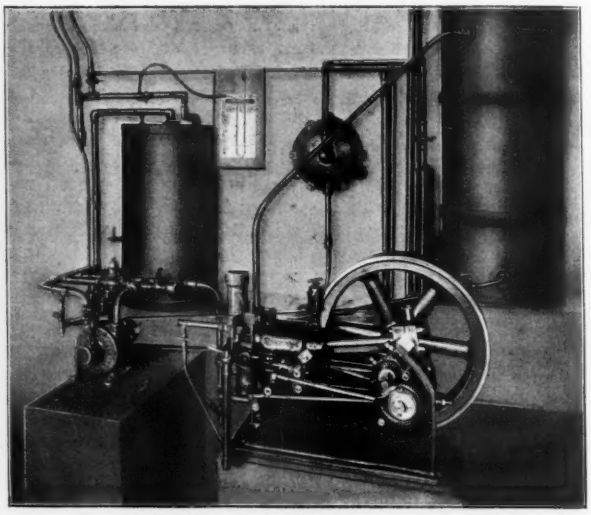


Burning-off and Seasoning Mantles at West Bromwich.

of supply; secondly, by improvements in burners; thirdly, by the selection of the most suitable mantles; fourthly, by having a perfectly organized and efficient system of maintenance. The great bulk of the gas manufactured is still used for lighting—most of that lighting being obtained by means of the incandescent mantle; and it is only by continued efforts that a time will come when illuminating tests will be abolished, and other tests substituted, relating to the heat-carrying capacity of the gas and its illuminating value when used with an incandescent mantle.

It is doubtless due more to the introduction of improvements in incandescent lighting in general, and that of the inverted burner in particular, than to the competition of electricity, that the quantity of gas manufactured in the United Kingdom has not increased during the past few years in quite the same ratio as in former years, and that in many towns the output has been seriously decreased. If, however, this can be attributed to such improvements in the uses of gas, the effect can only be temporary, and must, in the long run, prove beneficial. In West Bromwich, the substitution of incandescent lighting by inverted burners for flat-flame burners in churches, public buildings, and factories has in many cases effected a reduction in the consumption of gas varying from 50 to 75 per cent.

Somewhat similar conditions will, in all probability, be observable in the electrical industry, consequent upon the introduction of metallic filament lamps, which can now be obtained at very low prices, and which develop more than double the amount of light from a given quantity of electricity that can be obtained from a carbon filament lamp. But little reassurance will be found in the reflection that

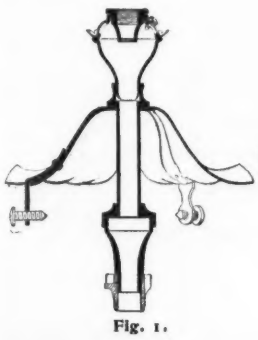


Apparatus for High-Pressure Lighting or for Burning-off Mantles.

present-day voltages are unsuitable for these lamps, or that the supply of metals—such as tantalum, tungsten, and osmium—is too limited to have any far-reaching effect; for doubtless these also are only temporary difficulties. The fact, which the author has proved by experiment, that the tantalum lamp will work for a reasonable length of time with an average expenditure of current not exceeding 1·8 watts per candle power, should be sufficient to stimulate the efforts of those whose opportunities are the greatest for the improvement of gas lighting.

Recent developments in incandescent lighting demand continual attention to the conditions of supply. Few inverted gas-burners will work satisfactorily with less than

Christ Church, West Bromwich. Lighted with Inverted Burners controlled by Switches.
Photograph taken by Gaslight only—15 Minutes Exposure.



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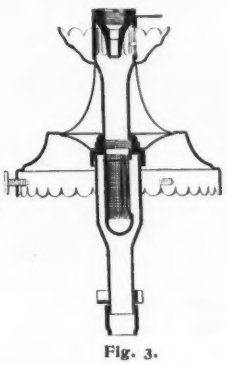
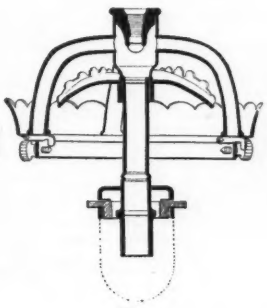


Fig. 3.



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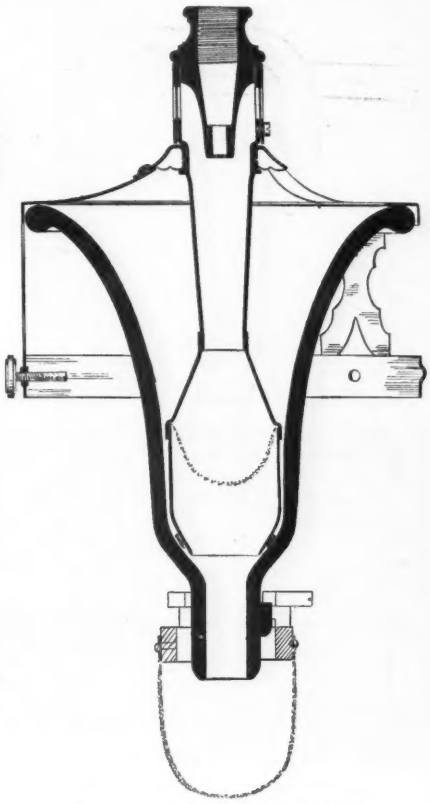
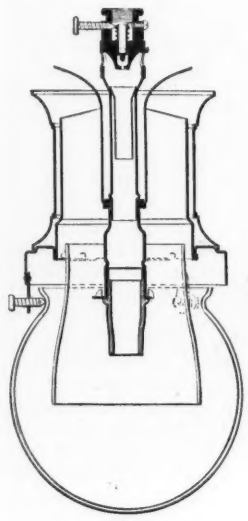


Fig. 7.—Bernt and Cervenka's Burner



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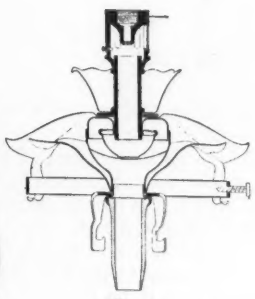
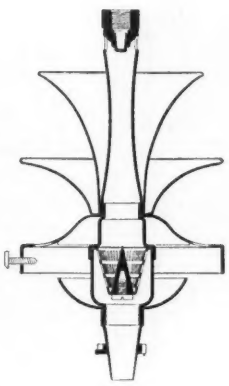


Fig. 4.



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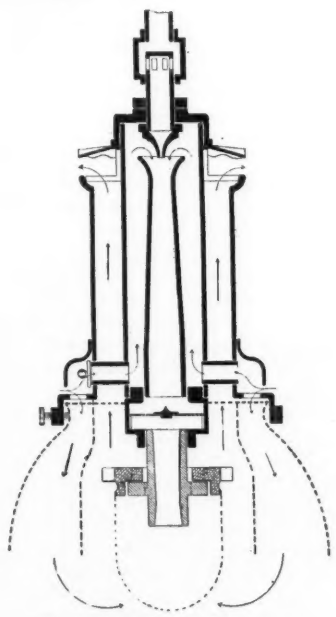


Fig. 8.—Copp's Inverted Burner.

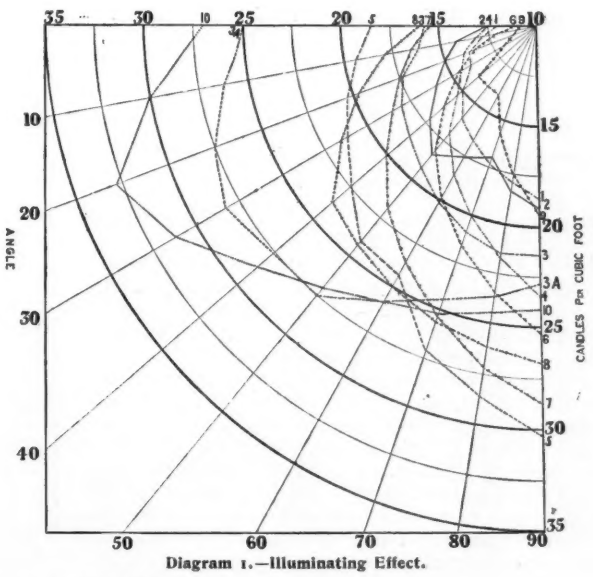



Diagram 1.—Illuminating Effect.

DRAWING No. 1.—PENDANT BURNERS.

15-10ths pressure. Moreover, it is necessary that the pressures in the district should be more constantly maintained than formerly; and in towns where the mains are overworked, much benefit will be derived by taking charts of the pressures in various portions of the district (say) once a fortnight, and adjusting the works pressure with the object of reducing variation to a minimum.

Mr. Victor A. Rettich, in his paper before the Illuminating Engineering Society in New York, in March, 1906, asserted that inverted burners were unsuccessful in that city, and that Fire Insurance Companies demanded higher premiums for buildings in which they were used, on account of the dropping of particles of incandescent carbon. This state of affairs is probably accounted for by the fact that the gas supplied in New York is credited with an illuminating power of 23 candles, and is distributed at a pressure of from 10-10ths to 15-10ths—conditions which preclude the use of nearly all the low-pressure incandescent burners at present obtainable. The use of water gas also has an important bearing upon the subject; and as this gas requires less air for its combustion than ordinary coal gas, it will be a growing necessity that fairly constant proportions be maintained—inverted burners being particularly susceptible to every variation in the composition of the gas.

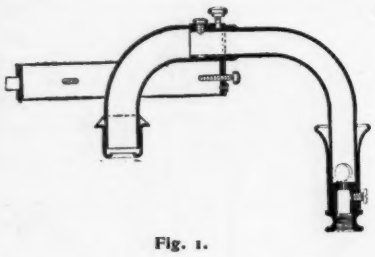


Fig. 1.

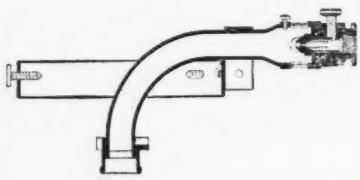


Fig. 3.

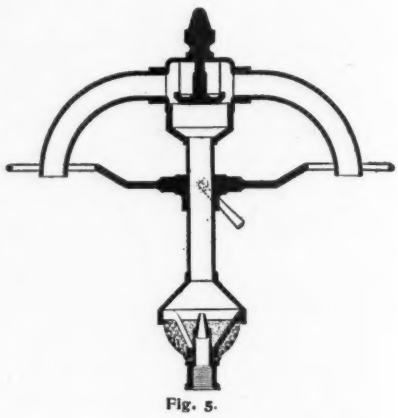


Fig. 5.

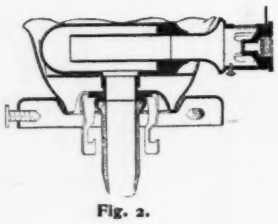


Fig. 2.

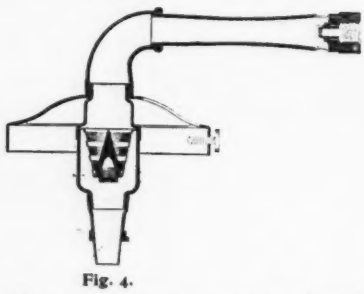


Fig. 4.

DRAWING No. 2.—ANGLE BURNERS.

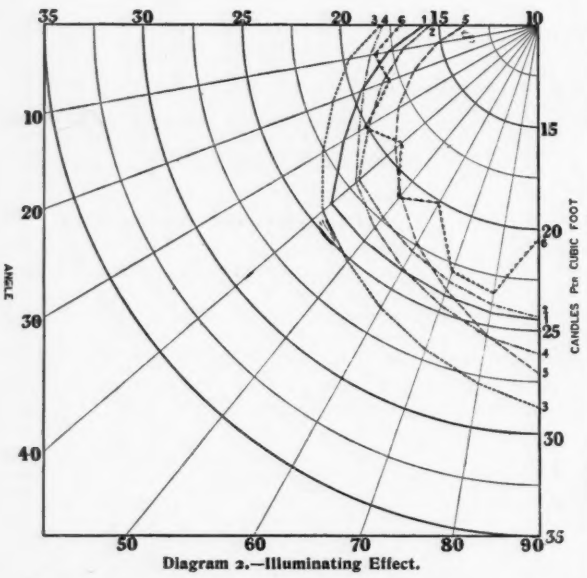



Diagram 2.—Illuminating Effect.

Passing on to the consideration of low-pressure burners, the ideal burner is one in which sufficient air is injected and mixed with the gas for its complete combustion, as from this flame the maximum temperature would be developed. But, in practice, at any rate with vertical burners, it is only by forcing the mixture through a small orifice at a high velocity, that these conditions can be approached.

M. Clamond invented an inverted burner in 1905, in which, after it has become thoroughly hot, and has attained its normal condition of working, he claims to inject practically the whole of the air necessary for the combustion of the gas before its ignition. Three-and-a-half parts of cold air are injected and mixed with the gas; and, at the point of ignition, three more parts of heated air are projected into the mantle with the flame. M. Lecomte obtained more than 40-candle power per cubic foot from this burner.

Of vertical burners, the Kern burner, shown on Drawing No. 3, still maintains its supremacy, and is probably as nearly perfect as a low-pressure burner can be made. The Bandsept burner (fig. 5), which is now used extensively in Paris for street lighting, also gives an excellent result. The mantles with which the tests recorded on Diagram No. 3 were made were not suitable for the burner, which is of different dimensions to those commonly used in this country, or the results would have been higher. The peculiar feature of the burner is that it has two superimposed injectors, which produce a good mixture, and the flame is highly aerated, even with pressures as low as 6-10ths.

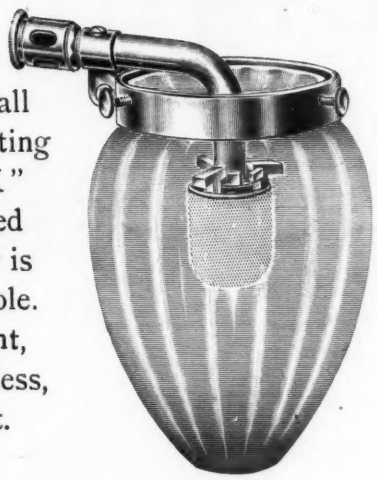
The form of injector used in a burner bears a very direct relationship to its efficiency. It is well known that a certain quantity of gas issuing at a certain pressure from one round hole has a greater kinetic energy than has the same quantity of gas issuing from a hole of some different shape, or from a number of smaller holes. The single hole, however, is often objected to on account of the noise it produces. It was stated by Herr H. Süssman before the German Association of Gas and Water Engineers, in November last, that the force available for the injection of air varies directly with the square of the velocity of the issuing gas.

On experimenting with burners fitted with various forms of adjusters, it will be found that the highest efficiency is given by an adjuster in which the hole is maintained fairly circular in form, or in which, if there are more than three holes, the adjustment is made by closing them successively. A needle-valve, in which the gas issues from an annular space, gives a lower efficiency. The author, prefers, however, to dispense as far as possible with the use of mechanical adjusters, and finds it generally more satisfactory, when fitting up installations of incandescent burners —especially of the inverted type—to take a record of the pressure at the point where the burners will be fixed, and to adjust them to those exact conditions in the test-room before they are sent out. If this is done, very few complaints will be received, and the use of governors, which means the lessening of the available injecting power of the gas, will be unnecessary. The same course is followed in street lighting, with great advantage.

No less important than the form of the injector is the design and shape of the mixing tube, the correct form of which is well known, but is seldom applied by inventors of burners. After having found an injector which will utilize the maximum energy of the gas, some of this energy can be expended in effecting the thorough mixture of the gas and air in the burner-tube. The shape of the tube, besides its effect on the mixing, ought also to some extent to serve for the prevention of striking-back; and this can be done by constricting the tube at a certain point, and thereby increasing the velocity of the mixture sufficiently to prevent an explosion being propagated back to the injector.

Professor Smithells, in his lecture before the Institution in 1905, stated that the theory of mantle luminosity was a difficult subject. It is certainly one which must be dealt with by the physicist rather than by the gas engineer; but as far as the latter is concerned, whether the illuminating power given by a mantle is due to catalytic action or to what is now known as the theory of selective radiation, the object is to get a flame as hot as possible by effective injection and perfect mixture, and to shape a mantle of the right texture and composition to that flame—the outer zone, consisting of burning carbonic oxide and hydrogen, being the hottest. Professor Smithells found the temperature of the bunsen flame to be 1870° C. when fully aerated, and more than 100° C. less when insufficiently aerated; and it has been recently shown by Dr. Gray that a reduction of a few degrees in the temperature causes a great diminution in the light-giving power of the mantle. Vertical burners having an arrangement for introducing a secondary supply of air under the head, and producing a hollow flame, have been tried. The author has, however, found them to be generally

# "K"



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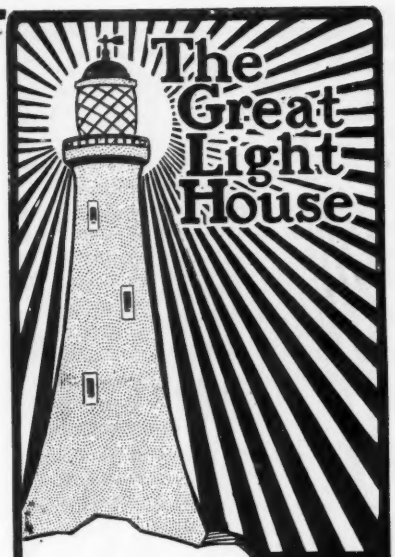


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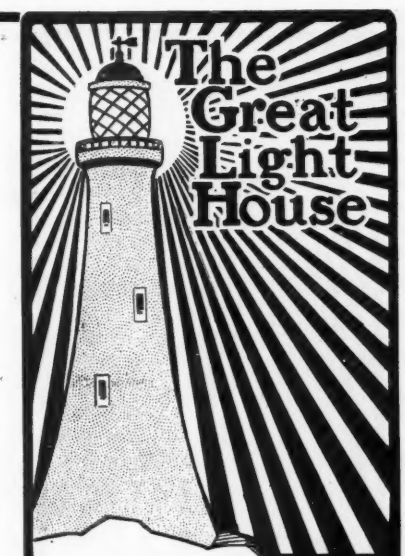


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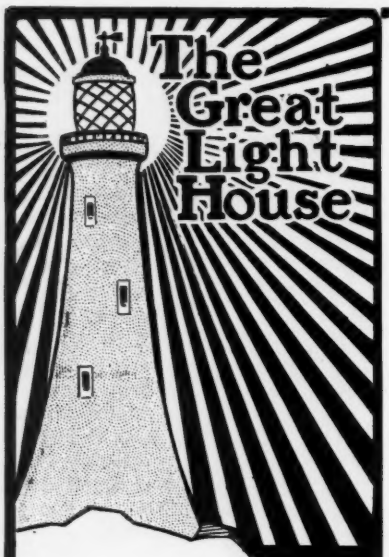


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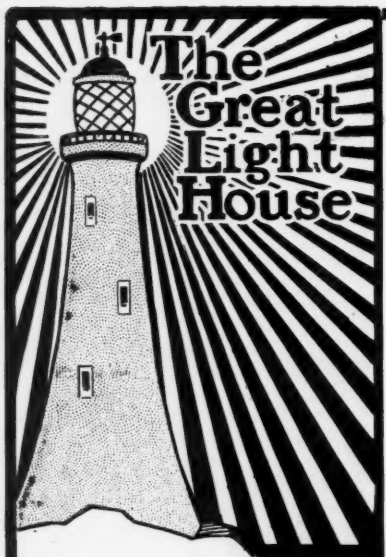


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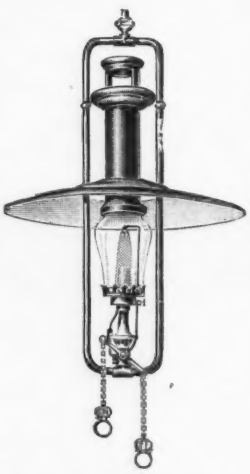

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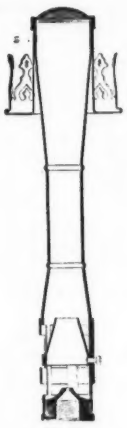


Fig. 1.

Fig. 2.

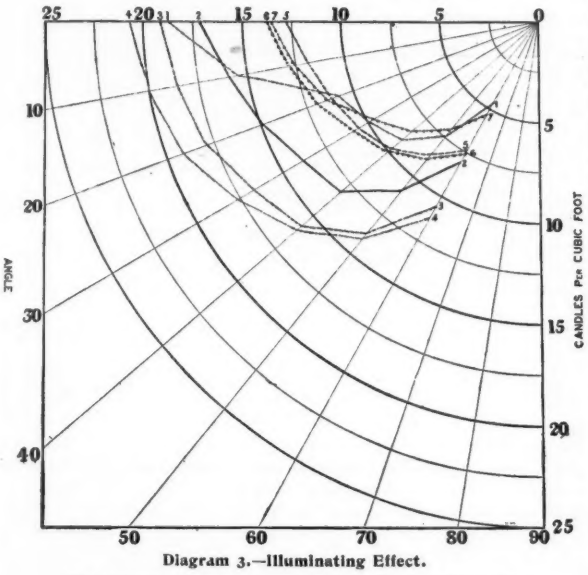



Diagram 3.—Illuminating Effect.

DRAWING No. 3.—VERTICAL BURNERS.

unsatisfactory, as the secondary air is not mixed with the gas, and merely exercises a cooling effect on the flame.

Extraordinary as the progress of incandescent lighting has been, that of the inverted burner, in spite of the prejudice which it encountered at first, has been phenomenal; and little is now heard of what was regarded as the fallacy of attempting to burn gas in a downward direction. Professor H. Drehschmidt, in his paper before the German Association of Gas and Water Engineers, on "Inverted Gas Lighting," gives the results of his very valuable investigations, which clearly show what an important effect the future of this system will have upon the gas industry. It is only just over seven years since the first inverted burner of Messrs. Bernt and Cervenka was placed on the English market. It was formerly thought that the first necessity of an inverted burner was that the tube should be as perfectly insulated as possible, either by the use of some non-conducting material or by a metal sleeve arranged to act as an air-jacket. It has, however, since been amply demonstrated that it is only really necessary to have the tip of a burner constructed of non-conducting material.

Inverted burners may now be divided into two classes; the one having for its object the insulation of the burner-tube, and the other the utilization of the facilities which inverted burners present for the pre-heating of the gas and air. The most notable form of the first class is the latest pattern of Messrs. Bernt and Cervenka's burner (fig. 7), which, it will be seen, gives a high efficiency. Metal tips are objectionable, as the heat conducted by them from the burner often causes some of the gas to be partially carbonized before reaching the flame; the result being incomplete combustion, causing the blackening of the top portion of the burner or of the ceiling above it, and, in some cases, an objectionable smell. Burners having this defect can often be made to work well by substituting a nozzle composed of either steatite or clay. The chief drawback with most burners whose tubes are well protected from heat is that the character of the flame differs so much when cold and when hot. If it is to be satisfactory when the burner is hot, the flame is so much over-aerated when lighted that it is liable to strike-back. As the burner gets hot, however, it becomes less atmospheric, owing to the decreased tendency of the heated mixture in the tube to descend. The application of the principle of regeneration is thus limited; and, if accompanied by serious diminution of the aeration of the flame, it is much better dispensed with.

It is an advantage that a burner should attain its normal condition of burning as soon as possible after being lighted; and with this object in view, the author has designed a burner (fig. 8) in which the tube is enclosed in a chamber through which the primary air reaches the injector; so that, as it becomes hot, and the tendency of the mixture to descend is lessened, and that of the primary air is correspondingly increased. In practice, the flame of this burner remains nearly as atmospheric when hot as when first lighted; and the inner cone does not perceptibly lengthen, the heating of the mixture giving it a high efficiency. It will be also noticed that the lower part of the burner-tube is larger in diameter than usual, to allow ample room for the mixture after being expanded by the heat, and that the orifice of the burner is specially designed to impart the desired shape to the flame. Another advantage which it possesses, in common with some others, particularly No. 5, is that the primary air cannot be contaminated by the products of combustion. [A curve of the illuminating effect will be seen on Drawing No. 1.] The author has found it advisable not to fix any inverted burner if, after it has been lighted for (say) a quarter of an hour, the inner cone is more than two-thirds of the total length of the flame. Mr. F. J. Litle, of New York, has designed a burner with a thermostat introduced into the tube for the purpose of automatically regulating the air supply as it becomes heated.

In the working of inverted burners, it will be found that most of the complaints are caused by particles of solid matter from the pipes being carried forward by the gas into the injector. Consequently it is advisable, where possible, to fix a suitable dust-trap, especially if a distance lighter is used. In a new burner invented by Mr. George Helps, of Nuneaton, there is an ingenious device whereby the injector (which has a ground joint) can be easily removed for cleaning purposes. All inverted burners should have a suitable canopy or deflector fixed at the top, preferably as a part of the burner, in order to diffuse the heated products of combustion, and prevent them from impinging directly on the ceiling. Aluminium is the best metal for this; being less liable to discoloration than others commonly employed.

The blackening of ceilings attributed to inverted gas-burners is often due to the use of a bye-pass. All bye-passes, after descending to the point at which the particular burner is found to light best, should be turned up, and fitted with a steatite tip. A large number of inverted burners which were disposed of in West Bromwich shortly after they were introduced some five years ago, were apparently made for gas with lower illuminating power than that supplied, and caused so many complaints of smell, and the blackening of ceilings and fittings, that it was found advisable to exchange, free of cost, the original burners for others of a cheap but fairly efficient form; and this course has been amply justified. In the lighting of churches and public buildings with inverted burners, there is risk of the globes or shades dropping, due perhaps to a small hole in the mantle allowing the flame to play on the glass. Where this danger exists, the author makes a practice of enclosing the globes and shades in a network of fine nickel wire.

With regard to the various methods of intensified lighting, the self-intensifying system does not appear to have made any very marked progress recently, depending, as it does, entirely on the length of chimney for its efficiency. If this is unduly increased, the lamp becomes unsightly; while the chimney gives the flame such a high velocity, and elongates it to such an extent, that if a certain length of chimney is exceeded, the efficiency decreases. The wear and tear on the mantles is also heavy, and double mantles cannot be used with these lamps, as the interstices do not allow the flame to escape with sufficient rapidity.

The various systems in which the gas or gas and air is compressed may now be divided into two classes—the one working with a pressure of from 8 to 15 inches, the other with a pressure of from 40 to 54 inches. Opinions

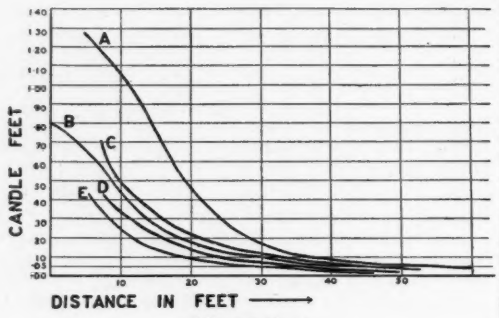



Diagram No. 4.

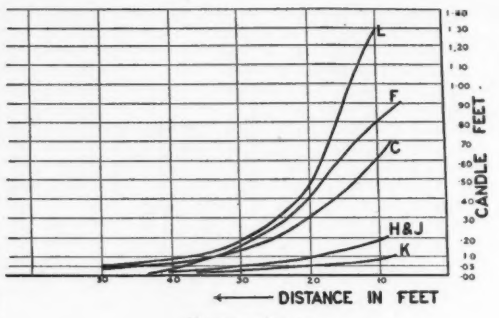



Diagram No. 5.

CURVES OF STREET ILLUMINATION.

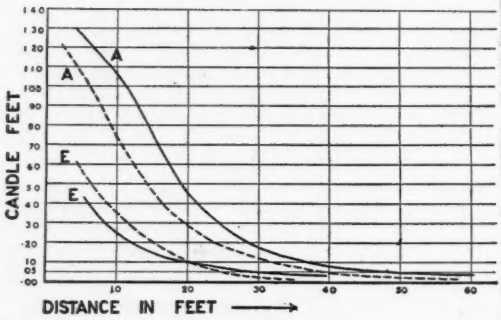



Diagram No. 6.

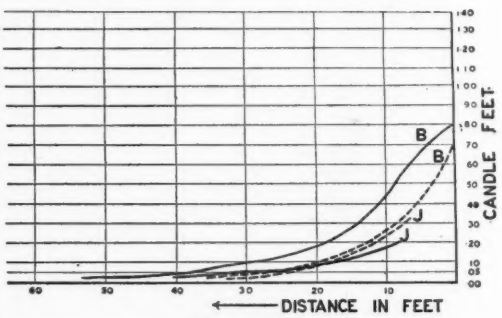



Diagram No. 7.

COMPARISON OF METHODS OF TESTING.

will differ as to which is the better from all points of view. The author's experience is, however, that the higher pressure gives the more satisfactory result. Another system is one in which the gas is compressed to 4 inches, and is mixed (previous to ignition) with two parts of air, or to 10 inches, and mixed with one part of air.

The primary necessity of compressed gas systems is undoubtedly simplicity. The systems working with pressures up to 15 inches can be operated very conveniently by town water pressure; and, for those using higher pressures, a rotary blower will be generally found simpler and cheaper than a reciprocating pump. Those involving the compression of gas or air, however, will not be generally adopted until the plant is much simplified and cheapened. The author has employed a small rotary blower, working at 2 lbs. per square inch, and driven by means of an electric motor or small gas-engine, and has found this method very cheap and efficient; the only apparatus required being a valve for automatically returning the surplus amount of gas, which also acts as a pressure regulator. Adjustments from 10 to 100 inches can be quickly effected, by means of a thumbscrew on the valve; and the pressure is indicated by a mercury gauge.

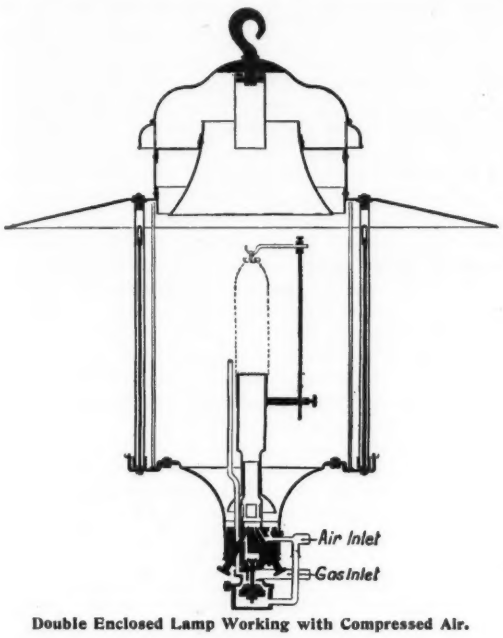
Various lamps have been constructed with a thermopile operated by the waste heat, connected to a motor in the base of the lamp, for impelling the gas forward to the burner. No lamp, on this principle, however, appears to have yet attained any large degree of popularity.

There is another system, which will probably become more popular in the future—namely, that in which the air is compressed instead of the gas. Mr. Scott-Snell utilized the principle by constructing a lamp, the waste heat of which operates an extremely ingenious automatic pump fixed in the top of the lamp. In another application of the same principle, the air is compressed to 2 lbs. per square inch, and is delivered to the lamps through pipes. The air can be used in a special nipple, arranged to inject an increased volume of air with the gas, which may be at a very low pressure. A portion of one of the main streets in West Bromwich is lighted on this system. A volume of air equal to that of the gas consumed is compressed to 2 lbs. per square inch, and delivered to fourteen lamps through a $\frac{3}{4}$-inch pipe. The apparatus, consisting of a rotary blower, driven by a small water-motor, is fixed in a chamber beneath the pavement; and the air pressure can be arranged to turn the gas on, so that it is only necessary to start the motor in order to light the lamps. Another application of the principle is that in which all the air necessary for complete combustion is delivered inside the lamp. The air so delivered having been previously filtered, the interior of the lamp remains clean for long periods, and it may be used in very dusty situations. The author has had this system at work in the retort-house at the West Bromwich Gas-Works with highly satisfactory results; and there are also other installations at work in the town.

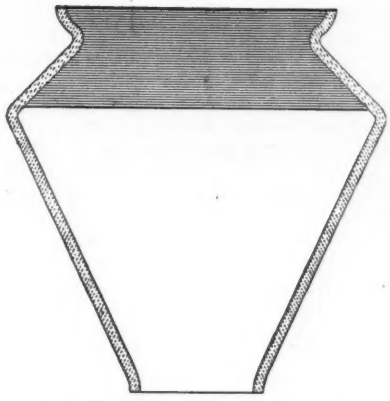
Various high-pressure systems were tried for the lighting of the tramway routes. It was necessary, however, that, as the lamps were to be attached to the poles, they should be of the "arc" pattern; and it was found impossible to obtain lamps of this type suitable for high-power units, which were perfectly ventilated and storm-proof. The system was abandoned, therefore, and small inverted burner lamps were eventually adopted. With regard to the burners for high-pressure lighting, it will be generally found that the simpler their construction the better will be the results obtained; the only necessity being a large chamber containing gauze for ensuring a proper mixture of the gas and air. Several types of inverted burners can be utilized for high-pressure gas, by fitting them with a smaller injector, and attaching a nozzle to impart the correct shape to the flame.

As a result of practical experience with most of the high-pressure systems, the author is of opinion that, unless they are maintained and supervised by the gas company, they will usually be found unsatisfactory. Some records of the illuminating power and efficiency of the various systems above referred to will be found in the Appendix. The tests were made with a photometer bar 15 feet in length, and the 10-candle Harcourt pentane standard. Though the illuminating power developed by the compressed mixture of equal parts of gas and air was obviously the highest, it was found impossible to obtain a test, as the high temperature developed melted the top of the burner.

In conducting the laboratory tests of incandescent burners (which will be found recorded in the Appendix), many difficulties were encountered. First, it was impossible to get one globe, or one type of globe, to fit all the burners. The burners having the ordinary $3\frac{1}{2}$-inch gallery were all tested with a plain conical globe, the top portion of which was of opaline glass, and set at an angle of 45°. Other burners could only be tested with globes with which they were supplied, so that due consideration must be given to this point when comparing the tests. In cases where the burners were not provided with an adjuster, they were first tried without mantles, and the consumption adjusted. After the mantles were fixed, they were tried at various pressures up to 20-10ths, in order to ascertain at what pressure their




Double Enclosed Lamp Working with Compressed Air.



Opal and Flint Globe Used for T sting.

Street Lamp with Inverted Burner and Double Reflector.

efficiency was the highest. Excepting in Nos. 10 and 3A, greater pressures than 20-10ths were not used, as they are seldom available at the consumers' burners, at any rate in provincial towns. The burners were then tested at all angles from the horizontal to the vertical.

The curves clearly show the difference in conditions which is brought about by the use of inverted burners. Whereas lighting from the walls of a room was best with vertical burners, lighting from the ceiling is much more advantageous with inverted burners; and it is this feature which makes the latter admirably adapted for the lighting of factories, where there are large numbers of machines. For domestic use, however, for the sake of appearance, the lighting of the top portion of a room should not be altogether neglected. It will be noticed that the burners in which a central glass ring is used in conjunction with a globe having no opening at the bottom, give a high result; the illumination of the mantle being much more intense, owing to the air being more or less heated before coming into contact with the flame. In conducting the tests, the author has been much struck with the variation in the translucent properties of opaque glass. Globes of this material produce a pleasing effect; and some which absorb no more than 15 per cent. of the light, and through which the outline of the mantle is hardly discernible, can now be obtained. It will be observed that elbow-burners are not generally as efficient as pendant burners.

The whole of the tests, excepting those of the large units, were made on a 60-inch bar, with a 10-candle Harcourt pentane standard, and a Simmance and Abady "Flicker" photometer. The standardization of globes and mantles, and methods of testing, would be extremely desirable; but the author confesses his inability to suggest any means of bringing this about.

Although many minor improvements have been effected in the manufacture of incandescent mantles, and those now obtainable are much more reliable than formerly, there is still great room for improvement. It is satisfactory to learn, however, that a new mantle, which is the result of the researches of Messrs. Plaissetty and Bruno, will shortly be obtainable. The mantle is manufactured under a new process, and is claimed to be more or less plastic, so that the risk of fracture is minimized. The Plaissetty soft mantle has been known for a considerable time in this country, and possesses many advantages. Not the least is that it shapes itself to the flame; and not being burned off and collodionized in the same way as the cotton or ramie mantles before reaching the consumer, there is less liability to damage in transit. The mantle, as at first produced, sometimes shrank excessively on being ignited; but this difficulty has now, to a large extent, been overcome. The author has found it profitable to obtain uncollodionized mantles for maintenance and street-lighting purposes, and to provide a small plant for burning them off. This plant consists of a gas-engine driving a rotary blower, similar to the arrangement used for high-pressure lighting. The gas is used at pressures varying from 2 to 5 lbs. per square inch; and mantles can be burned off to any desired shape to suit different kinds of burners.

In conducting photometrical tests of various mantles, it will be found that the relationship of the mesh of the mantle to the character of the flame, is an important factor. A slow and sluggish flame generally gives the best results with an open-mesh mantle, although one of close mesh very often conveys to the eye the impression of giving more light. There are burners and mantles on the market which make full use of this illusion.

The author's experience is that the maintenance of inverted burners is much less costly than that of vertical burners; and in many places where a large number are in use, they can be profitably maintained at a yearly cost of 1s. per burner. The following table gives the mantles used on the various classes of maintenance in West Bromwich:—

*Mantles Used for Maintenance,*

From October, 1906 to March, 1907 (inclusive).

| Type of Burner. | Situation. | Description of Mantles. | Mantles per Burner. |
|---|---|---|---|
| * "B" Inverted (square lanterns). | Street Lighting. | Collodionized. | 3·10 |
| * Inverted (arc pattern lamps). | ,, ,, | ,, | 2·80 |
| * Inverted (3 burners per lamp). | ,, ,, | ,, | 3·35 |
| "C" | ,, ,, | ,, | 5·90 |
| ,, | ,, ,, | ,, | 5·77 |
| Inverted. | ,, ,, | Uncollodionized. | 4·10 |
| "C" and Kern. Inverted. | Shops and Residences. | Both. | 3·25 |
| ,, | ,, ,, | ,, | 4·40 |
| ,, | Churches. Schools. | Uncollodionized. | 1·78 |
| ,, | ,, | ,, Collodionized. | 2·20 |
| | | | 5·20 |

* Lamps fixed on tram poles; mantles consequently subjected to severe vibration.

The difficulties connected with the ignition of burners are, perhaps, more than anything else, retarding the progress of gas lighting at the present time. The pilot-jet, in spite of its many drawbacks, still remains in general use. The greatest difficulty of all mechanical systems is that a perceptible time must elapse after turning on the gas before it can be ignited. There are numerous electrical lighters obtainable; but these are all more or less bulky, and somewhat expensive. Automatic ignition by means of platinum black is not employed to any large extent in this country. There are several small igniters on this principle; but they are slow in action, and often deteriorate rapidly. If, however, they are suspended at the correct point, and the burners are kept clean, so that the flame is thoroughly atmospheric, their life is much prolonged. The author

has had several attached to inverted burners, which have been in operation over twelve months. In Germany, self-lighting mantles are employed to some extent—a small pellet of spongy platinum, to which strips of ammonium platinum chloride are attached, being secured to some part, of the mantle. But the mantles are somewhat expensive, and are more or less uncertain in action.

The author has successfully used a coil of fine platinum wire, enclosed in another coil of iron wire for protection from the action of the flame; the current from two dry cells being sufficient to cause almost instantaneous ignition of the gas. The platinum coil lasts for a long time; but not more than three lights can be operated in the same circuit. The gas is turned on by means of a pneumatic switch; and the flow of current is controlled by a bell-push. The pneumatic tube is insulated with cotton, and is used as a conductor of the current; the wire being "earthed" to the gas-pipe for the return. The arrangement in its present form, however, is too expensive to be generally employed.

The well-known device for turning on gas from a distance by pneumatic pressure has been found extremely useful in the lighting of churches, as well as in domestic lighting. In the case of the former, it is often desired to reduce the light during certain portions of the service; and for this purpose the author has successfully employed the pneumatic distance-lighter, in one case by turning out alternate lights, and in others by turning off certain pendants. Bye-passes for these burners will be generally found more reliable than electrical igniters. Though the mixture of gas and air descends from 4 to 8 inches from an inverted burner before it is lighted, ignition can only be effected at a point near to the orifice. Some burners are found to light best with the pilot-jet just below the ring of the mantle, and others with the jet some 2 or 3 inches above the mantle. In church lighting, after the type of burner to be used is decided upon, it is important that this should be determined by experiment; for if a number of burners failed to light during a service, the result might be serious.

There is also another system, invented by Mr. Thomas Glover, of Norwich, and two of his assistants, in which the gas is controlled by means of a tumbler switch, on the principle that when the pressure is reduced by the gas being almost turned off (only sufficient being allowed to pass to keep the bye-pass alight) an automatic valve closes the main supply to the burner. When the switch is moved into the reverse position, the full gas supply is again allowed to flow through the pipes; and this raises the valve controlling the main supply to the burner. Water pressure has also been utilized for operating burners from a distance. Baron Auer von Welsbach has succeeded in producing an alloy of cerium and iron which, on being struck lightly, emits a shower of sparks capable of igniting a burner; and it is possible that by this means many of the present difficulties will be overcome.

The curves on Diagrams Nos. 4 and 5 show the results of tests of various systems of street lighting in use at West Bromwich. It will be observed that, although inverted mantles emit their maximum light in a downward direction, nevertheless, if suitably arranged, they illuminate a road very effectively. Two mantles arranged in a line at right angles to the direction of the road give a much better distribution of light than one. With inverted burners, there is always the risk of a mantle dropping completely off, without previously showing any signs of fracture. When single mantles are used, therefore, it is advisable to enclose them in a fine network of nickel wire, with a clearance of about 1 inch round the mantle. If there are two or more, the appearance is much improved by placing them close enough together to resemble one source of light. The curves are plotted to show the light falling upon the ground surface in candle-feet, as it is only in this way that the degree of patchiness of the lighting by inverted burners can be compared with that of vertical burners.

With a view to projecting some of the downward light from an inverted mantle along the road, a lantern was constructed having a conical reflector at the bottom, as well as at the top; and Curve C shows the improvement due to the use of this arrangement. The lantern from which Curve E was taken is similar to the above, but is only fitted with a flat porcelain reflector above the burner. The curves would, of course, have been much flatter had the light falling upon a vertical plane been plotted instead.

The tests from which Diagrams Nos. 4 and 5 were prepared were made by means of a Preece-Trotter portable photometer, which was described by Mr. Henry Fowler, of Derby, in his paper on street photometry before the Manchester District Association of Gas Engineers, in December, 1902, and was kindly lent by him to the author for the purposes of this paper. The tests shown in broken lines on Diagrams Nos. 6 and 7 were made by means of a street photometer, fitted with a pentane lamp, which was standardized with the flame at different heights on the laboratory photometer with a 10-candle Harcourt pentane lamp—a Simmance and Abady "Flicker" instrument being used in each case. Observations were taken at intervals of 10 feet from the base of the lamp column; and the illuminating power was calculated in accordance with the law of inverse squares. The exact distance having been ascertained by diagram, the illuminating power was divided by the square of this distance, giving candle-feet, which, on being multiplied by the cosine of the angle between the direction of the light rays and the vertical or normal to the road surface, gives the light falling upon that surface.

The readings of the Preece-Trotter instrument are taken from a pointer moving through an arc, calibrated in candle-feet by means of the cosine law. The variation in the results by the respective instruments is largely due to the fact that, whereas the former only shows the illuminating effect of the lamp under test, the latter receives illumination from all sources. There are also many possibilities of error in the measurement of street illumination—such as the varying reflecting power of adjacent buildings, the condition of the road surface, and the state of the atmosphere.

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## Appendix.

### Street Lighting.

Notes referring to Curves on Diagrams Nos. 4, 5, 6, and 7.

A.—Arc pattern lamps with two inverted burners, each consuming 4½ cubic feet per hour. Fitted to tram-poles on alternate sides of the road, 106 feet apart, 15 ft. 6 in. above pavement. Tests taken along the curb.

B.—Arc pattern lamps, similar to "A," but having only one inverted burner, consuming 4½ cubic feet per hour.

C.—Special square lantern, with reflector top and bottom, fitted with one inverted burner, consuming 4 cubic feet per hour; 11 feet above the pavement. On alternate sides of the road, 160 feet apart. Tests taken along the curb.

D.—Square lantern with no reflector, fitted with double inverted burner, consuming 7 cubic feet per hour; 11 ft. 6 in. high. On alternate sides of the road, 180 feet apart. Tests taken along the pavement.

E.—Square lantern, similar to "C," but with reflector over top only.

F.—Single enclosed 5-ampere electric arc lamp on tram-poles along the centre of the road, two lamps on alternate poles; 17 ft. 3 in. above the road. Poles with lamps on average 240 feet apart. Tests taken along the centre of the road.

G.—Self-intensifying, 200-candle power, in hexagonal lanterns; 11 ft. 6 in. high.

H.—"C" burners with steatite tops in square lanterns, with flat reflectors; 10 ft. 6 in. high, on alternate sides of the road, 120 feet apart. Tests taken along the pavement.

J.—Same as "H," ordinary "C" burner.

K.—Electric incandescent lamps, 11 feet high. Used instead of "F," from 11 p.m.

L.—Compressed-air burners. Two arc pattern lamps, 13 feet high, on each tram-pole in the centre of the road, 100 feet apart. Consumption, 15 cubic feet per hour. Tests taken along the centre of the road.

*Highest Efficiency Observed with Various Systems of Intensified Gas Lighting.*

| System. | Consumption (Cubic Feet). | Pressure (Inches of Water). | Illuminating Power. | Candles per Foot. |
|---|---|---|---|---|
| Self-intensifying . . | 21 | 2·4 | 592·2 | 28·2 |
| Compressed gas . . | 16 | 54·0 | 584·0 | 36·5 |
| Do. | 14·7 | 11 0 | 460·1 | 31·3 |
| Compressed air . . | 10·5 | 54·0 | 340·0 | 32·0 |

Compressed gas and air not tested.

*Pendant Burners.*

| Burner Number. | Pressure Tested at. Tenths. | Consumption per Hour. | Gas used for Testing. | | Kind of Globe. | Remarks. |
|---|---|---|---|---|---|---|
| | | | Illuminating Power. | Calorific Power. | | |
| 1 | 20 | 3·25 | 16·98 | 634·9 | Opal and flint. | Aluminium top. |
| 2 | 20 | 3·25 | 16·28 | 630·8 | Clear, constricted in middle. | Needle adjuster. |
| 3 | 20 | 3·90 | 16·60 | 619·0 | Opaline. | No air admitted at bottom of globe. |
| 4 | 20 | 3·50 | 16·21 | 611·0 | Clear fluted. | Opal cone fixed on gallery. Flame under-aërated. |
| 5 | 20 | 3·80 | 16 54 | 634·9 | Opal and flint. | Inner cone of flame short. |
| 6 | 20 | 3·20 | 16·96 | 624·9 | " " | Tubes convey air from gallery to injector. |
| 7 | 18 | 3·20 | 16·80 | 630·0 | " " | Enamelled cup, which acts as reflector. |
| 8 | 20 | 3·40 | 16·96 | 634·9 | " " | Porcelain insulator, " " |
| 9 | 20 | 1·55 | 16 81 | 626·5 | Clear conical. | Bijou, with porcelain insulator. |
| 3A | 22 | 4·00 | 16·81 | 626·5 | Clear optic. | No air admitted at bottom of globe. Longer mantle used; illumination at side consequently greater. |
| 10 | 22 | 3·60 | 16·80 | 620·0 | " " | |

*Angle Burners.*

| Burner Number. | Pressure Tested at. Tenths. | Consumption per Hour. | Gas Used for Testing. | | Kind of Globe. | Remarks. |
|---|---|---|---|---|---|---|
| | | | Illuminating Power. | Calorific Power. | | |
| 1 | 20 | 3·00 | 16·96 | 624·6 | Opal and flint. | No adjuster on burner tested. |
| 2 | 20 | 4·25 | 16·82 | 620·0 | do. | |
| 3 | 20 | 3·00 | 16·54 | 642·8 | do. | Adjuster, one hole, keeps fairly circular during adjustment. |
| 4 | 20 | 3·25 | 16·54 | 642·8 | do. | Needle adjuster. Mixing chamber in burner. |
| 5 | 15 | 3·65 | 16·90 | 634·0 | do. | No adjuster. Mixing chamber in burner. |
| 6 | 20 | 6·40 | 16 43 | 607·0 | No globe. | Two mantles. No adjuster. No reflector. |

*Vertical Burners.*

| Burner Number. | Pressure Tested at. Tenths. | Consumption per Hour. | Gas Used for Testing. | | Remarks. |
|---|---|---|---|---|---|
| | | | Illuminating Power. | Calorific Power. | |
| 1 | 20 | 4·00 | 16·73 | 610·26 | Clear 6-inch chimney. |
| 2 | 16 | 3·85 | 16·73 | 610·26 | do. |
| 3 | 17 | 2·65 | 16·80 | 612·06 | Clear globe. |
| 4 | 15 | 4·00 | 16·80 | 612·06 | do. |
| 5 | 18 | 4·90 | 16·73 | 608·42 | No chimney or globe. |
| 6 | 18 | 4·10 | 16·81 | — | Mantle bad fit. |
| 7 | 20 | 3·40 | 16·31 | 619·04 | No chimney or globe; no gauze in burner-top. |

## Discussion.

Mr. W. R. HERRING (Edinburgh), as one who had devoted some considerable attention to the question of inverted gas-burners, both for public and private lighting, said he would like to heartily congratulate the author of the paper on the very exhaustive manner in which he had treated the subject. It was quite evident that Mr. Copp had had a large experience of the burners he had dealt with, and that he had devoted very close attention to them; because it was only those who had to find out the efficiency of what were the best burners for various purposes who could have discovered the great variety there was, and the many little causes which had such great effect in producing the best results from the burners. If in the remarks he was about to make he disagreed with the author, it was not in an unfriendly spirit, but merely meant to show that the subject was not exhausted, and that there was still room for others to carry on their investigations. In the first place, he should like to refer to the portion of the paper where the author spoke of few burners giving satisfactory results at less than 15-10ths pressure. He (Mr. Herring) was quite prepared to agree with him in this; and he might say that out of 19 burners which he had tested, there were only two that gave satisfactory results at the pressure named. On the other hand, the greatest efficiency from the majority of the burners was obtained at from 25-10ths to 30-10ths; and this was a very important factor to be considered. Another question with reference to pressure was this: He thought that, if fairly uniform, when they had discovered the pressure at which a burner gave its best efficiency, as the pressure was increased whether or not they had a governor on it, it had no effect; and, as a rule, they had the same relative candle power per cubic foot of gas with an increased consumption due to the increased pressure. On the other hand, when the pressure varied much, particularly at night with the public lamps, when it was reduced below 20-10ths or anything below 15-10ths, they had incomplete combustion, a smoky flame, and carbon deposit on the burner-tip. This was a thing they had to deal with in Edinburgh. He thought those who had tried it would admit that, whether or not one had a governor on an incandescent burner, it did not act; and they would find that the consumption increased with the pressure at the base of the governor, which, as a matter of fact, did not govern. In coming to an arrangement with the lighting authorities and adjusting the consumption for the public lighting in Edinburgh, they were obliged to get average charts of the maximum pressure. The result was that during the night the burners were each passing only $1\frac{3}{4}$ cubic feet of gas per hour. This was the figure for midnight; but during the lighting hours proper, they were burning $2\frac{3}{4}$ cubic feet. So that, on an average, they burnt $2\frac{1}{4}$ cubic feet per hour per burner. The author suggested that a needle-valve, in which the gas issued from an annular space, gave a low efficiency. Strange to say, he found that a burner with this type of adjustment gave the very best efficiency. A discrepancy like that only proved that there was room for investigation on the point. Then, still dealing with the question of pressure, the author said that to take a record the position of the burner should be fixed. This might be possible in certain cases. There had been some discussion the previous day as to the necessity for a uniform pressure. As a practical man, he thought it was physically impossible to know what the pressure would be in any particular locality at any given time, unless every house was governed independently of the street system. His point was that the success of a system must not depend on their adjusting the burner for the position it had to occupy, but they must have a burner of such a character as to meet all the varying conditions to be found at the present time. There was just one point as to inverted burners, and the utilization of the facilities they presented for the pre-heating of the gas or air, or both. It was found, on investigation, that it was the burner which got the pre-heated air supply unvitiated which gave the best results. The unvitiated air supply to an inverted burner was responsible for 25 per cent. of the increased efficiency. With regard to some of the diagrams, as he read them the author's results were very much lower than his own. All the tests were made on the horizontal plane; and he was wondering whether the upper part of the globe, which the author said was opal, by any possibility cut off some of the light rays from the photometer disc. They knew that an opal shade would absorb

fully one-third of the light emitted by the burner; and as Mr. Copp's results were so much lower than his own, he thought there might be something in the point. The author went on to say that the burners were tested at various pressures up to 20-10ths. He (Mr. Herring) thought it was a mistake to stop there. No doubt they were arriving at a period when much higher pressures were to prevail in their districts; and where incandescent lighting was found to be a success, the pressure would be seen to be very high compared with what it was ten or fifteen years ago. If the author would repeat some of his tests above 20-10ths pressure, he (Mr. Herring) thought he would get different results from those which his diagrams illustrated. On the question of maintenance, he could fully support Mr. Copp's statement, not only for public lighting but also for factory purposes. He had had occasion to fit up a large rubber-works with some 3000 burners. They undertook the maintenance in these works, where there was a great deal of vibration from moving machinery and so on; and his figures, which he was not then prepared to state, fully supported the author's opinion.

Mr. GEORGE HELPS (Nuneaton) said Mr. Copp very kindly came over to see him when he was dealing with the subject of his paper, and suggested testing some of the burners connected with his main. But he thought, after consideration, it would be better to leave them out altogether. To his mind, the paper now before them resolved itself into a call for uniformity of pressure. Of course, he did not mean a uniform pressure of 5-10ths day and night, but one which was sufficient to give the customer a reasonable result in his burner; and he thought, if the paper were looked at from this point of view, they would all be more in agreement with it. Mr. Copp had said that the burner depended upon the efficiency of the injector—on the power to inject the mixture at such a velocity that it would not strike-back. It would be admitted that if they had pressure at the burner all chance of striking-back was removed. It would further remove the trouble to which Mr. Copp had alluded with regard to the structure of the flame. If the products of combustion were carried away, they would have none of these troubles. Turning to the diagrams that had been placed before them, if they assumed (as he took it they were asked to do) that the mantles in each case were of the same make, and of such a size as was best suited to the flame, the diagrams would show which suited Mr. Copp's conditions for the gas and the burner, so far as lighting was concerned. If, however, the mantles were not of the same make, so far as the efficiency of the light was concerned the diagrams had no value. In other words, the mantle played a more important part than the burner. In regard to this point, he had an authority which he should like to quote. He had in his hand a copy of a lecture delivered by Professor Lewes, some years ago, and published in the "JOURNAL OF GAS LIGHTING" in May, 1896, in which that gentleman alluded to the illuminating value and effect of incandescent mantles. He said:

> It seems at first sight almost hopeless to reconcile the statements made by various observers as to the light emitted by mantles; but these wide discrepancies depend to a great extent upon the conditions essential for obtaining proper results having been neglected. In order that a mantle shall fulfil its object properly, it must fit that portion of the flame which is generating the highest temperature; and unless the mantle is uniform in shape, and the gas supply is so regulated as to bring the proper portion of the flame in contact with the mantle, the true illuminating value cannot be developed. The result of this is that, if the gas supply is too small, the mantle is not properly immersed in the flame, and only partial incandescence results; while if the flame is of sufficient size, turning on more gas only increases the consumption without any adequate increase in illuminating value. Even when the gas supply is carefully regulated to the size of the mantle, it is not by any means uncommon to find the light emitted by different sides of the mantle varying by as much as 8 per cent. Another point which has been to a great extent overlooked is that the illuminating value of the mantle varies with that of the coal gas with which it is used. In all gases made by the retorting of coal, the volume of hydrogen and carbon monoxide undergoes but slight alteration, while the illuminating value depends upon the hydrocarbons present; and the higher the proportion of these, the greater will be the heating power developed by the combustion of the gas, and the higher the duty of the mantle. With London coal gas, the mean of a large number of experiments with the present Welsbach mantles gave 16 candles per cubic foot of gas as their illuminating value. Mantles have been tested which gave 19 candles, while others have only yielded 11 candles.

He thought this carried the point, so far as the diagrams were concerned, unless the mantles were of the same make. While on the question of mantles, he wished to refer to a point they all knew—viz., that in fixing mantles on to burners they were very often put on, just burnt off, and lit, instead of being put on and left for a considerable time to harden. With regard to the author's design of burner No. 8, he thought this was his (the speaker's) child. Still Mr. Copp considered it was his; and he saw there was in all probability a gentleman in Germany who would think it was his. He did not follow what the author had said with regard to the kind of nozzle which should be used. Did he mean that the temperature of the nozzle could not be different, whether it was metal or china, when it was surrounded by a flame?

The PRESIDENT said that they were favoured with the presence of two gentlemen who were engaged in the manufacture of these burners—Mr. Bray and Mr. Bland. As he was sure the meeting would be glad to hear what they had to say, he would call upon them to speak.

Mr. ARTHUR BRAY thanked the President for the privilege of being allowed to speak at the meeting, but said he was quite unprepared to discuss the paper, which he had listened to with great interest, and with most of which he agreed. On the question of whether the nozzles of the burners should be porcelain, steatite, or metal, he had started off, when he first made inverted burners, with a porcelain nozzle; but within a very short time, he was sorry for it. They were found to be unreliable; and they had not yet been able to find one that was reliable. They seemed to get a better effect from a metal nozzle. They obtained a better flame; and though the nozzle did in time wear out, it lasted fully a lighting season through. He noticed that Mr. Copp did not care much for burners with bent arms. The curved-arm inverted burner had several advantages. In the first place, the products of combustion were kept away from the air-inlet to the burner. This was, of course, as everybody knew, a very great point. Secondly, with a curved burner they were able to keep the products of combustion away from the fittings, and in this way avoid spoiling them very quickly. There was still a great deal to be learnt about inverted burners. He himself was learning every day something new; and he never felt that he had come to the end of his investigations. Some day he hoped to make public the results of nine months' constant experimenting, mainly with inverted burners. The subject was a most fascinating one to study.

Mr. BLAND thanked the President for being allowed to be present to hear the paper, and said he did not quite agree with what the author stated about needle-valves giving low efficiency. His experience was that, taking them all round, they showed better results. They found that there was no noise resulting from using a three-cornered needle which entered a round hole.

Mr. R. WATSON (Doncaster) wished to endorse what had been said with reference to Mr. Copp's most admirable paper. There was a great deal of instruction to be obtained from it, and many things to which it would be useful to refer afterwards. First of all, with reference to the question of pressure, Mr. Herring had alluded to the point that 15-10ths was not sufficient to give adequate results. He quite agreed with him. Recently he had been making some tests with the "flicker" photometer, and he found that the best results were obtained at a higher pressure than 15-10ths—viz., 20-10ths. As the illuminating effect increased with the higher pressure up to 25-10ths or 30-10ths, the calorific value died away after passing 25-10ths. No doubt inverted burners required a greater pressure than gas managers had been accustomed to employ. As had already been suggested, they had not adequate pressure in their mains for ordinary purposes. He was rather inclined to think that high pressures were required throughout the whole of the day. Recently he had had experience of the metal-weight loading of a governor and water loading, and had found, to his astonishment, that cutting off the 10 minutes while he increased the pressure and decreased it, whether in the night or not, it had the effect of reducing his leakage something like 2 million cubic feet in the course of twelve months, which meant a difference of 1½ per cent. It also happened that the decrease occurred from quarter to quarter with the change. This suggested that there was a possibility of their having high pressures at the wrong time. Looked at from another point of view, it might be that the 2 million cubic feet of leakage of gas might have been "usefully wasted," because practically the value of this quantity was only £100; and it was probable that they got more than £100 worth of satisfaction from their consumers throughout the district. Referring to the diagrams, he could scarcely tell why Mr. Copp said that

angle burners gave better results. They certainly did so if one looked at the rays that were sent down to the floor; but if they took an average of the whole of the lines on each sheet, there did not seem much difference. If Mr. Copp would pardon him for rather strongly criticizing some of the lines on the charts, he should like to suggest that what he had been testing in the majority of cases had not been burners and mantles, but burners *plus* globes. The burner had generally been supplied with an opal and flint squat. The opal portion was at an angle of, roughly speaking, 45°. That was to say, many of the rays which he got from his burner were reflected from the burner downwards. The maximum rays were at an angle of something like 65° to 90° —practically almost on the ground. He would suggest that it would have been fairer if Mr. Copp had used a clear globe throughout the tests, or that he should use the globe he suggested—viz., an opalescent one. This would absorb a certain percentage of the light; but, at any rate, the results at all angles would be comparable. Mr. Copp had shown at line 6 on Diagram No. 2 the effect of the burner without the globe. It would be noticed that the rays were almost the same as with a globe—that when they reached the ground the effect of the reflector was at once pronounced, throwing the rays downwards to the floor. This particular burner was more useful for internal than external lighting. It was more useful for domestic lighting than for any other purpose. It was evident that people having such a burner, with a globe of that character, in any room where they were reading, if they glanced up they would get the direct rays of the burner in their eyes; and these rays were accentuated by the character of the globe itself. They would be constantly troubled by the intense brilliancy of the incandescent burner—to their physical disadvantage and personal discomfort. This kind of burner was more suitable for schoolroom work, where it was placed higher than in a small sitting-room. But in that case, again, the higher the burner, the less was the illuminating effect. So that it would probably be better to have an opalescent globe obscuring not more than from 10 to 15 per cent. of the light, which would give a more general light on the table where one happened to be at work. He wished for a moment to refer to the curves of street illumination. These were obtained from certain lamps as used at West Bromwich, whereas the paper itself was on the general character of incandescent gas lighting. The curves represented the illuminating effects from inverted burners used in street lighting, compared with other inverted burners, and with no vertical burner except the "C." The reflector was evidently of a very good description, though personally he should prefer it to be convex. But, unfortunately, in the case of inverted burners of this description, with the maximum rays going downwards, such a reflector had very little to reflect. Mr. Copp had realized this, and he had added at the bottom a reflector, which also was concave in character. But this only caught the rays falling at an angle of 80° to 90°, and dispersed a portion of the rays upwards instead of horizontally into the street. Yet, in spite of all this, Mr. Copp obtained much better results than he did with a "C" burner giving horizontal rays which were nearly all utilizable. Again, in connection with the "C" burner, he (Mr. Watson) was sorry that in making his tests Mr. Copp did not use a concave or a convex reflector instead of a flat one. Flat reflectors were of no use whatever in street lighting. Had he used a concave or preferably a convex one, he would have had much better results than he had shown on Diagram No. 4 by the letters H and J, which referred to a "C" burner. He (Mr. Watson) had on a number of occasions tested Kern burners with convex and concave reflectors, and had better results than Mr. Copp had obtained with the H and J "C" burners. If they were to take a good specimen of an inverted burner, taking the illuminating power, and calculating the amount of light that would be given at a height of 11 feet at different distances along the ground, and then take account of the amount of light given at the different angles, while they would get the best results from the pendant burner at the base of the column, they would get the worst results at a distance of 40 feet and upwards from the column. Mr. Copp evidently found it otherwise, judging by his line E and his lines H and J. Of course, it could be easily done. The optical photometer would convince them, if they were to stand at the base of the column having inverted and horizontal burners, that the inverted ones gave more light at the base. With reference to the question of the cosine and inverse-square law, Mr. Copp had used the cosine law; but he thought they would get much fairer results if they used the inverse-square law for experiments like those which had been described in the paper.

Mr. Walter Grafton (Beckton) said that Mr. Copp had referred particularly to the variations in the composition of gas affecting the result. This was not at all his experience. He thought it was not wholly the burner; it was a question of suiting the injector action of the burner to the composition of the gas. With regard to the mantle, the finer it was the better the result, but the greater would be the maintenance; and their object should be to reduce this as low as possible. He had had burners going night and day for more than two years. The results given for the burners in the paper were somewhat low, considering that some figures related to burners which were in themselves partially reflecting. The results should be obtained from the burner pure and simple, without any globe. The globe being pear-shaped tended, of course, to concentrate the current of air, and bring it on to the mantle.

Mr. Copp, in reply, said he was afraid he had abbreviated his paper too much in reading it, because many of the observations which the speakers had just made were fully answered by the paper itself. He was much obliged to Mr. Herring for the remarks he had made, and he was very interested to learn what he had found with regard to the question of the injector. He should like to know whether the needle-valve which Mr. Herring used had any supplementary hole for injecting, or whether it was simply gas issuing from the annular space.

Mr. Herring said it was a Bland burner.

Mr. Copp, in further reference to Mr. Herring's remarks, said of course the candle power, and no doubt the calorific power, of the Edinburgh gas was much higher than that at West Bromwich; and therefore higher results would be expected. He also quite agreed that the efficiency of the burner would be very much greater with higher pressure. But, as stated in his paper, he was strongly of opinion that, in the majority of cases, at the lighting hours greater pressures than 20-10ths were seldom available. They always tried to keep this pressure in the mains; but it was not more than 20-10ths in the consumers' houses. With regard to Mr. Helps's observations, he did not expect the Institution to take his tests as gospel. They were simply results which he had found in his experience, and from which he ventured to think some useful conclusions might be drawn. With the particular gas-burners represented, he had no doubt he could reproduce the same results. But in another town, with a different gas supply and other burners, he was perfectly sure he could not. Mr. Helps made a remark with regard to the shape of the mantle and the kind employed. When burners were supplied with mantles, he invariably used the mantles to which he had referred. In other cases, of course, he used a uniform kind. It was not necessary to say which. As to the shape of the mantle, he emphasized this point in his paper; but he omitted it in reading, because the same remark was made in connection with the other papers. The quotation Mr. Helps had read from Professor Lewes's lecture almost exactly coincided with one particular paragraph in his own paper. He was not aware that Professor Lewes had written it; he wished he had known it before he wrote his paper. With regard to the criticisms offered by Mr. Watson and Mr. Grafton, he found that it was impossible to test the burners without the globe. In some cases they could not get a reasonable result at all without one; so that he was led to the necessity of adopting some kind of globe. But he could get very few, because the glass, if it was uneven in thickness, would act as a lens, and completely upset the results. Therefore the globe had to be very carefully selected in order to get comparable results. Of course, he got some reflecting power by the opal at the top; but all the other burners were under exactly the same conditions, and there was generally no use for a globe which was more or less a reflector. With regard to Mr. Watson's remarks about the lamps, he regretted that he had not tested vertical burners with reflectors. The reason for this was that not one of his curves represented what he should say was an ideal vertical street-lantern. They were all taken from the type of lantern which they happened to have in use; and he had no doubt they could be improved upon. This was the reason why he had adopted the inverted burner, because he saw there was great room for improvement in the existing system. In conclusion, he wished to thank the various members who had taken part in the discussion.

## THE USE OF TAR ON ROADWAYS.

**By Mr. H. P. MAYBURY (Member of the Institution), County Surveyor of Kent.**

Since the passing of the Motor-Car Act, 1903, the question of the satisfactory maintenance of the main roads in the country has become a serious one. In a comparatively few years a revolution in the use of the national highways has taken place; and much greater progress has been made in three years in getting "Back to the Roads" than has taken place in ten times that period in the "Back to the Land" proposition. Perhaps since its freedom from legislative restrictions, no industry in modern times has made such headway as that of motor manufacture. Giving evidence before the "Royal Commission on Motor-Cars" in October, 1905, Mr. T. F. Woodfine, the Secretary of the Society of Motor Manufacturers and Traders, stated that, up to that date, no less a sum than £6,000,000 had been invested as capital in undertakings for motor-car construction. The same gentleman stated that the then wages bill of such undertakings represented £1,189,730 per annum.

At this moment, in the County of London alone, upwards of 25,000 motor-cars have been registered. In the County of Kent in the year ended the 31st of March, 1906, no less than 1151 cars were registered; and during the year ended the 31st of March last, a further 643—the total number registered at the end of the last financial year in Kent being 3099. Other counties (particularly those in the home district) show increases in about the same ratio. With this great augmentation of an entirely new kind of traffic, it is no wonder that the roads in many instances have been found unsuitable, and that a great public outcry has been raised against the high speeds attained, and the dust nuisance occasioned thereby. That the roads should at all have supported this enormous additional traffic redounds to the credit, in no small degree, of the local governing bodies and their officers.

The average Englishman, however, likes his grumble; and if there is one subject more than another upon which the "Man in the Street" considers he is an authority, it is that of road construction and maintenance. Few realize the great difficulty under which the road engineer has to carry out his duties. The chief one is that of finance. Prior to the passing of the Local Government Act, 1888, half the cost of the maintenance of the main roads was provided out of Imperial funds. Since that date, the cost of upkeep has almost doubled, while the Exchequer contribution has not materially increased; the consequence being that the local ratepayer has had to bear the additional burden. The demand now is for better and dustless roads; and it is one the surveyors of the country have done, and are doing, their best to meet with the limited resources at their disposal.

As has already been pointed out, 25,000 cars are registered with the London County Council. These cars travel over the main roads maintained by the rural ratepayer, while the fees for their registration go into the coffers of the London County Council. The same unfair incidence obtains in all the great centres of population. There is reason for hope, having regard to his remarks in his recent Budget speech, that the Chancellor of the Exchequer has the whole matter of local taxation under consideration, and that at an early date a scheme will be propounded which shall be more equitable, and that the cost of road improvement and dust abatement will be more directly put upon the users of the road. Motorists as a body would not object to increased licence duty if the funds derived therefrom were utilized for road improvement purposes. With additional Imperial aid, local governing authorities and their technical advisers will be found equal to making dustless roads; and in pursuance of this, the author is of opinion gas manufacturers will materially benefit.

Since the year 1903, many experiments have been made and numerous chemical compounds have been used with more or less satisfactory results; but it is now generally conceded that nothing is so effective as coal tar. The Royal Automobile Club, in conjunction with the Motor Union, recently offered prizes for the best machine for applying tar to the roads, and also for the best tar preparations. The author was asked to join the Committee appointed to adjudicate in this matter; and it was extremely gratifying to him to find the premier Gas Company of Great Britain among the competitors submitting preparations, while one of their officers—Mr. Reeson—exhibited a machine for its distribution.

The mileage of the main roads of England and Wales is 23,826, and of other public roads 95,211; total, 119,037. The cost of maintenance in the year ended March, 1904, was—

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| Main roads | £1,694,577 |
| Other public roads | 2,093,400 |
| Total | £3,787,977 |

The main roads cost on an average £71 per mile.

With tar at 1½d. per gallon, the cost of painting the surface of a mile of road, when such work is performed by mechanical means, varies from about £30 to £40; and assuming the whole of the main roads to be so treated, an annual addition of £1,000,000 would be required.

This work would represent a yearly consumption of 33,400,000 gallons of tar; its value being something like £208,000. It would thus appear that a new market of considerable importance will shortly be opened up; and it should be the aim of every gas engineer to encourage in his immediate neighbourhood the use of tar for road purposes, by putting the purchaser upon the most-favoured nation terms.

During the past three years, the Kent County Council have purchased tar representing £1000 a year; and the author regrets to say that he has often found it cheaper to buy from the distiller than from the gas company direct. One such case may be recalled. The author was about to treat a mile of road in an urban district, and personally applied at the local gas-works for a price for tar, "per cask of 40 gallons." The quotation was very high, and he proceeded to ascertain how the bulk produced was disposed of. Having obtained this information, he communicated with the distiller, who offered to supply a roughly refined tar, in casks at 3d. per cask less than that quoted by the gas-works manager, notwithstanding the double freightage charge. This is short-sighted policy; no one but the carriers deriving any advantage. Thanks to Sir George Livesey, the writer is able to obtain supplies for use in his county at the low price of 1d. per gallon, to which, of course, freightage has to be added.

It is common knowledge now that the use of tar for road purposes is far removed from the experimental stage. For many years now it has been the recognized treatment of some of the most important roads in Paris. That well-known and eminent road engineer, Mr. Howard Humphreys, in giving evidence before the "Royal Commission on Motor-Cars," in reply to a question put by the noble Chairman, as to whether he had any suggestion to make about the practical method of improving the roads for the purposes of motor traffic, said: "There are several methods, varying of course in expense, with the degree of importance of the traffic. To begin with, the method of hot tarring, more rolling, and using less binding, will, in my opinion, do a very great deal towards making a road strong and good. I have been recently in France inspecting some roads in the City of Paris, and around Paris, where hot tar has been used; and I must say that, although I went a disbeliever, I came back absolutely converted to the use of hot tarring under proper scientific and climatic conditions." With all modesty, the author heartily endorses this opinion. Tar treatment has been a failure in some instances; but it has always been due to the non-observance of the scientific and climatic conditions so happily referred to by Mr. Humphreys.

The writer quite recently had the pleasure of an interview with Dr. Guglielminetti, of Paris and Monte Carlo, who has had perhaps the longest experience of anyone of the benefit of tarred roads; and he is most enthusiastic thereon—finding in favour of tar after having experimented in a hot and dusty climate with all the palliatives yet put upon the market. During the year ended March 31 last, 53 miles of main roads in the writer's county were coated with tar—manual labour being employed. In all respects but that of cost, the work accomplished was satisfactory. During the long period of drought, these particular roads were free from dust, much to the comfort of the residents adjacent thereto.

Various opinions prevail as to the method of application—some preferring that the road-forming material (stone or slag) should be coated with tar before being laid upon the road; others that a fluxing matrix should be spread upon the old surface, and the re-coating material laid thereon and rolled; and there are some who suggest grouting-in the freshly applied material with hot tar after it has been consolidated in the dry state. Still another section prefer the road made up as heretofore, using the best hard material,

bound together with clean gravel and granite chippings; the tar being applied as a surface-dressing after the road has well dried out. Such a method is that preferred by the writer after having made experiments with each. But whichever method is favoured, the interest to the gas manufacturer is the same—coal tar being used.

In most of the Home Counties, tar-spreading operations are now being undertaken upon an extensive scale, notably in Essex, Surrey, and Kent; the writer having instructions to treat some 200 miles of the most important roads from London to the Coast. The cost of this treatment will be borne in equal shares by the districts desiring it, and the County Council.

Although the subject of road construction and maintenance is far removed from those generally dealt with and interesting to the members of the Institution of Gas Engineers, still, as modern practice seems to point to an increased demand for such an important bye-product as tar, with the co-operation of managers of works and the surveyors of highways, it is not unlikely that in the near future not only will the roads be made more congenial, but that also the credit side of the gas engineers' ledgers will be appreciably improved—due to the increased demand for this bye-product.

### Discussion.

The PRESIDENT, in inviting discussion, said the author of the paper, as the members would be aware, was formerly a gas manager; and he was sorry not to be able to welcome him among them once more.

Mr. J. C. BELTON (Chester) said he was glad the President had mentioned that Mr. Maybury had once been a gas engineer; but he should have expected that on this account he would have made a more sympathetic reference to the price of tar. When he talked about 1d. a gallon as the price of it for road-making purposes, all he (Mr. Belton) could say was that if gas companies could get only this for it, for the purpose named, they did not want the custom. They had seen the palmy days when 40s. per ton was sneezed at, and even 50s. was considered a very fair price. But those days were gone, and times had changed. He thought a standard price of 1½d. per gallon would be far more satisfactory than anything they were led to expect from the paper.

Mr. S. Y. SHOUBRIDGE (Lower Sydenham) said that in London they were not able to get the high prices for tar that Mr. Belton had talked of. In connection with all large towns, it would be found that 1d. per gallon would be a good price to get. [No, no.] He was very glad to hear that others were doing so much better than they were in London. He fully supported the hope that they would charge as low a figure as possible for their tar, because by this means they would be taking a large quantity out of the distillers' hands, and thus very considerably raise the price. He hoped they would bear this point in mind as justifying their keeping the price as low as they could.

Mr. J. FERGUSON BELL (Derby) thanked Mr. Maybury for his paper. He pointed out that what the author wished them to do was to supply the road authorities with tar at the same price as they obtained from the distillers. They wanted to encourage road engineers to use tar as much as possible; and thereby they would find an outlet for their products. There was no doubt that if they had less tar to sell to the distillers they would get a much higher price. When the figure to the distillers was increased, and the county authorities knew the value of tar, they would probably be prepared to increase the price to 1½d. per gallon. He was heartily glad Mr. Maybury had taken this matter up. All who did not use motor-cars would appreciate the efforts being made to enable them to enjoy their country walks as they should be in a position to do.

Mr. WALTER GRAFTON (Beckton) said that the price of tar was not the only thing to be considered. The method of putting it on the road was an important point. Mr. Reeson was now perfecting his machine for spreading the tar on roads; and they wanted to be able to draw their supplies from the local gas-works as they went through the different districts. The difficulty with coal tar was that it was so thick. By Mr. Reeson's machine, the tar could be heated up to 70° or 80°; and when spread upon the road it made a perfect finish, and was all that could be desired.

Mr. S. GLOVER (St. Helens) said it was their duty to consider tar from the road-making point of view; and they ought not to forget that they were tar makers not only in great cities, but spread all over the country. Seeing that coal was increasing in price, and that they, as engineers and managers of gas-works, had to pay more for coal, they ought to do their very best to increase the value, and consequently the price, of their bye-products as much as possible. He would therefore deprecate as strongly as he could, as a tar maker, any suggestion that they should "give" their tar away by selling it at such a price as 1d. a gallon, as this did not represent its fair value. While he was quite aware that there was too much tar in the country, and that, with the advent of the more successful working of such tar producers as their friend Mr. Bury was going to speak to them about, there was likely to be still more of it, it was essential that they should do all they could to see that tar was used to the best advantage, and render it as valuable as possible to the road maker. He was not surprised to find that there was nothing so effective as tar for road making. Starting with this as the basis of their considerations, there were two things aimed at—viz., dust prevention from road surfaces, and the more effective making of roads. They did not want to sell their tar only as an effective dust preventer, because for this purpose there were many effective chemical compounds which were used with good results in the country; but it was also wanted for the proper binding together of the roads. Tar was found to be most effective; but it must be used intelligently if it was to stay in the mind of the road-maker as the best material for his purpose. It must therefore be sold intelligently to the road-maker; and he (Mr. Glover) was not surprised to find that it had been found cheaper to buy tar from the distiller than from the gas company direct. Seeing that Mr. Maybury was in some measure a gas engineer, they had, he thought, a right to expect a little better treatment from him on the tar question, unless his views had been somewhat divided as a gas engineer and a road engineer. He was not surprised that he had found it better to get his tar from a distiller than from local gas-works, inasmuch as a large quantity of the tar he would require in the County of Kent would have to be bought from some small company. Tar bought in this way would be less suitable for use directly as a road-making and road-binding material. In their interests as gas engineers, such tar ought not to be sold in its raw state to be employed for the former purpose. He had nothing to say against the use of water-gas tar as a dust-preventing compound; but, as a road-making compound, he was of opinion that country tar was of less value and a great loss to gas engineers, through not being used intelligently at the gas-works before being sold to the road maker. Country tar would contain a large proportion of crude naphtha, which would have in it from 30 to 35 per cent. of benzol and the other lighter products of coal tar, which were less suitable for road-binding material. For this reason, it was cheaper to buy from the distiller than from the gas company direct. Mr. Maybury spoke about having been offered a roughly-refined tar; and he said it would pay him better to get it from the distiller, at 3d. per gallon in casks, than from a gas company. He (Mr. Glover) had been told that the tar would not be used cold; that it would be heated in some rough apparatus, and boiled till it was sufficiently tenacious. By this some of it would be lost to the road maker. He would therefore commend the consideration of this question to gas engineers, and ask them to consider the advisability of putting into their chief product much of the illuminating power which was often sold under the name of "tar." He would recommend putting this back into the gas, and only selling to the road-maker, at a fair and proper price, the portion of the tar that was the better suited for his purpose. Cold tarring could be done under certain scientific and climatic conditions; but it was very difficult indeed to use it in the open. As he had said, it ought to be prepared intelligently, and only sold at a proper market price.

The PRESIDENT asked Mr. Glover if he would explain what objection he had to country tar being boiled and used on the roads.

Mr. GLOVER said that, in his opinion, it was an improper use of a valuable material. The road-maker did not get a 40-gallon cask of usable tar when he bought 40 gallons of tar from a country gas company. He got a very much less quantity of tar that was usable for his purpose.

The PRESIDENT remarked that it appeared to be entirely a question of price.

Mr. E. ALLEN (Liverpool) supported Mr. Glover in his views when he said that tar should not be used merely for preventing the dust nuisance, but also for road making.

He spoke from information given to him by the City Engineer of Liverpool, who was an authority on the latter subject. This gentleman told him that his trouble for many years in the use of tar had been that he would get one lot from the distillers, use it on a certain specification, and it might turn out very satisfactory; but on working with the same specification with another lot of tar, it would be very unsatisfactory. His informant at last employed a chemist to deal with the matter, and insisted on buying his tar to a certain specification. He said he did not want a great deal of benzol. Of course, he required some of the light oils; but he wanted something consistent. He and the distillers conferred on the matter, and decided as to what was the most convenient specification to deal with. It was worked to, with the result that the roads were made in the most satisfactory manner, and the Company derived benefit from the fact that they obtained a market for their tar.

Mr. Trounsom (Southport) said he was interested in the question of road making; and, as the representative of a local authority, he had listened with great interest to the debate. The question of dusty roads was one that had been exercising the minds of road authorities for many years, especially since the advent of the motor-car. With regard to what Mr. Allen had said about Liverpool, there they had possibly got to the correct specific gravity at which tar should be used for road-making purposes. He might point out that someone who evidently had knowledge of what tar should be lived in Southport about 25 years ago, because he had had part of a road which was then laid cut out 5 inches deep, and the tar was now almost as full of life as on the day when it was put down. This was the secret of good tar road making. The question of price, which Sir George Livesey introduced some time ago, was one of the most important factors in connection with road making. Fortunately, those of them who owned gas-works and were also connected with the local authorities had in their own hands the manipulation of the price; but those who had to buy from gas-works, or from companies who were not associated with local authorities, were rather nervous about extending their tar road making until some fixed value had been placed upon the tar. He hoped this matter would be further taken up by the Institution, as they were the most competent body to deal with it; and he trusted they would give all the assistance they could to the local authorities in their efforts to provide dustless roads.

Mr. Douglas H. Helps (Reading) said he had received an invitation to be present at the tests which had been made of tar for road purposes, and he then met Mr. Maybury; and he wished to add his thanks to him for the work he had done to improve the roads in his district. The paper dealt with two sides of the question—one the mere dressing of the roads to prevent dust; and the other the mixing of the tar with granite or some other material for making up the road. He had seen the machines for spreading the tar; and he thought the best one was that which was devised by Mr. Reeson, of the Gaslight and Coke Company; and now the inventor had added the method of heating the tar, he (Mr. Helps) still further approved of it. The surveyors he met at the trials seemed to think they ought to design a machine for driving the tar into the roads. Some of the appliances they were using were designed for spreading the tar at a pressure of 120 lbs. The only way in which they could get it into the surface of the road for the prevention of dust was to give it time to be absorbed; and for this reason he disagreed with the statement that tar coming from a country gas-works would not be so good as that obtained in towns. On the contrary, he thought that it would be better, as containing the lighter oils. The important thing was to have the roads dry and apply the tar hot.

Mr. Paul Schlicht (New York) said he should like to refer to the use of tar, not on, but under, roadways, and to some experiments in this connection with which he had been associated. About the year 1893 he was concerned in a company which had to do with wares of various kinds produced from wood fibre; and among them were the pipes which took the place of the ordinary cast-iron pipes for insulating electric wires. About 150 miles of this piping was put down in the City of Buffalo for the Street Railway Company; and he learned about a year ago, from the engineers who laid it, that the pipes were in as good condition as when originally laid. He was also familiar with an experiment that had been made with this wood-fibre pipe treated with tar. Twelve years ago a pipe was put down for conveying gas. It was laid in a moist place, and when examined about a year ago was in just as good condition as it was originally. This was another use for tar.

The President said he was sorry Mr. Maybury was not present to reply to the discussion. The only observation he (the President) should like to make was with regard to having a standard price for tar, as to which there was nothing said in the paper. The author only referred to 1d. per gallon as being the figure at which he could obtain the tar through Sir George Livesey. This was only a price which had been fixed in order to encourage the use of tar. It was not by any means fixed for all time, but simply to enable surveyors to go ahead, and prove the utility of tar for road-making purposes.

## THE FINANCIAL SIGNIFICANCE TO THE GAS INDUSTRY OF THE MODERN BYE-PRODUCT OVEN.

By PAUL SCHLICHT, of New York.

At the suggestion of the distinguished President of this Institution, the author has the honour of offering some observations upon modern bye-product oven-gas production, which it is hoped may throw new light on a subject which he regards of great importance to the gas engineering profession at the present moment.

The members will not need to be reminded that their President was the first to bring the claims of the bye-product oven as an economic factor in gas production to the attention of English gas engineers in a very interesting paper which he read so long ago as 1896. The author has also to refer to another distinguished gas authority—Professor Vivian B. Lewes—whose encouragement infused him with the necessary assurance to advocate radical reforms in carbonization before one of the most conservative, as well as most efficient, bodies of gas makers in the world.

Before entering upon his subject, the author deems it essential to a full comprehension of the purport of his arguments that he should make a brief personal explanation of the underlying motives of his European researches.

### Recent Investigations in Europe.

Even if he should be chargeable, therefore, with digression, he is impelled—in order, as he believes, to properly pave the way for the introduction of various illustrative tables, descriptions, and estimates of bye-product oven systems, actual results of tests and observations, and estimates of financial possibilities—to briefly set forth the circumstances leading to nearly a year's bye-product coke-oven investigation in Europe. About 1903, he became associated with Mr Thomas A. Nevins, one of the organizers of the Public Service Corporation of New Jersey, controlling the highly successful Camden Coke Company, who supply gas made in bye-product ovens to many towns and cities, running their pipes a distance of some forty miles, to Trenton. The daring purchase of one of the old-time Newark Gas Companies, New Jersey, by Mr. Nevins, and its rehabilitation by modern business methods into a large money earner, gave him high rank as a far-sighted gas financier. He became President of the Newark Consolidated Gas Company and of the Haverhill (Mass.) Gas Company.

Mr. Nevins was at this time the owner of a going coal property, railroad, steamers, barges, &c., which he had acquired with the idea of controlling a number of gas companies and consolidating the coal and transportation properties therewith. The author's connection with the United States Gas Coal and Coke Company, as Mr. Nevins' Company was called, led to his making a proposition to one of the important parent gas-security holding companies to join in a bye-product oven undertaking. This was favourably considered, and the author was asked to make a full report on the financial possibilities of such an undertaking, which resulted in the Company's acquiring the coal and transportation properties and, with subsequent acquisitions in all, some 25,000 acres of coal lands. The author gives extracts from this report (p. 975), which passed the scrutiny of eminent experts, and was regarded as a fair estimate of possibilities—making due allowances for fluctuations in the value of products.

Results like those stated could only be predicated, as they were here, upon exceptional transportation facilities, low mining costs, and ownership and control of coal supplies. Perhaps there exist in England equally good opportunities.

TABLE I.

Estimated cost of plant (United-Otto ovens), $3,000,000.
Capacity, 3000 net tons of coal per day, 1,095,000 per year (365 days).
Gas output, 4,000,000,000 cubic feet per year of 20 candle power.

*Receipts.*

| | |
|---|---|
| 70 per cent. coke—766,500 net tons at $4 | $3,066,000 |
| 10 gallons tar per ton coal—10,950,000 gallons at 2 c., less 10 per cent. bye-product commission | 197,100 |
| 1 per cent. ammonia sulphate, 10,950 net tons at $40, less 10 per cent. bye-product commission | 394,200 |
| 4,000,000,000 cubic feet gas 20-candle power at 75 c. | 3,000,000 |
| | $6,657,300 |

*Expenditure.*

| | |
|---|---|
| 1,095,000 tons coal at $1·00 | $1,095,000 |
| Operation and supplies (40 c. per ton) | 438,000 |
| Distribution of gas, at (say) 16 c. | 640,000 |
| Depreciation | 150,000 |
| Net profit (with 75 c. gas) | 4,334,300 |
| | $6,657,300 |

It is one of the author's ambitions to see this estimate of his fully realized with the bye-product oven that as a result of his investigations is found the best for gas production.

Hereupon the author conceived the idea of utilizing a great coal property near the Ohio River, and supplying gas to several existing gas companies under a contract, which led to the plan laid before United States Senator J. B. Foraker, of acquiring by lease for 99 years the properties of the Cincinnati Gas and Electric Company, who were threatened in 1906 with an invasion into their territory of natural gas at an average price of about 10d. per 1000 cubic feet. The author contended that the low price of coal in Cincinnati would enable this Company to meet in a practical way this opposition by making high-grade coke and oven gas. The yields of surplus gas not being entirely satisfactory, the author determined upon a test in the improved United-Otto ovens with "Black Band" coal—the coal in question. He argued that every cubic foot of gas gained, either through superiority in gas-yielding properties of coal or superior efficiency of oven system, was equivalent to its selling price in the localities of its use. The test was to be in the United-Otto ovens, an improvement on the Otto-Hoffmann ovens in which Ellsworth coal had been tested, details of which are given in Table II. and in the Appendix.

TABLE II.

*Extracts from the Report of Tests Made by* Dr. F. BOGDAHN, *Chief Chemist, United Coke and Gas Company, at the United Otto Bye-Product Plant, Otto (Pa.), June 12, 1906.*

Coal received from the Olcott Coal and Iron Company.
Mine—At Olcott, Kanawha County (W.Va.).
Seam—"Black Band."

*Crucible Test.*

| | In Coal. | In Coke. |
|---|---|---|
| Volatile matter | 38·44 p.ct. | 0·93 p.ct. |
| Fixed carbon | 55·55 ,, | 89·39 ,, |
| Ash | 6·01 ,, | 9·68 ,, |
| | 100·00 | 100·00 |
| Sulphur | 0·69 p.ct. | 0·60 p.ct. |
| Phosphorus | 0·0101 ,, | 0·0131 ,, |

*Oven Test.*

Weight of coal charged, 13,034 lbs., less 2·47 p.ct. moisture.
Weight of dry coal charged, 13,034 lbs., or 6·517 net tons.

*Yield of Coke.*

Total yield of coke . . . . . 69·20 per cent.

*Yield of Tar.*

Total yield of tar, 842 lbs., or 6·46 per cent. of the dry coal.
Specific gravity of tar as produced, 1·1476.
Amount of water in tar, 4·52 per cent., sampled after three days.
Yield of dry tar, 6·17 per cent. of the dry coal.

*Yield of Sulphate of Ammonia.*

156¾ lbs., or 1·203 per cent. of the dry coal.

*Gas Produced (Including Sulphuretted Hydrogen).*

| | | |
|---|---|---|
| Total | 78,340 | cubic feet. |
| Per 2000 lbs. of dry coal | 12,021 ,, ,, | observed. |
| Corrected to 0° C., and 760 mm. | 10,597·9 ,, ,, | |

*Heat Balance per 2000 lbs. of Dry Coal.*

| | | | | |
|---|---|---|---|---|
| By a series of previous tests, the heat value of the gas used to heat the ovens during 28·40 hours was | 2,790,262·4, | or 43·03 | p.ct. of total | B.Th.U. |
| B.Th.U. of surplus gas | 3,694,642·5, | ,, 56·97 | ,, ,, | ,, |
| Total B.Th.U. of gas produced | 6,484,904·9, | ,, 100·00 | ,, ,, | ,, |
| Average B.Th.U. of gas produced | 611·9 per cubic foot. | | | |

*Surplus Gas.*

Average B.Th.U. of surplus gas . . . 694·7 per cubic foot.
Surplus gas per 2000 lbs. of dry coal, 5318·2 cubic feet—viz., 50·18 per cent. of the total gas produced.

*Illuminating Value of Surplus Gas.*

Total illuminating value . . . . . 102,949 candle-feet.
Average candle power of surplus gas . . . 19·36 ,, ,,

*Oven-Heating Gas.*

Average B.Th.U. of oven-heating gas . . 528·5 per cubic foot.
Oven-heating gas per 2000 lbs. of dry coal 5279·7 cubic feet—viz., 49·82 per cent. of the total gas produced.

*Weather.*

Fair. Atmospheric pressure, 740 mm. Temperature of gas at the meter—maximum, 34° C.; minimum, 26° C.

Shortly afterwards, arrangements were made with Mr. Frank Hastings, the accomplished President of the Indianapolis Gas Company and Manager of many gas enterprises in which Mr. E. C. Benedict is interested, to use this coal on the strength of tests in United-Otto ovens in his up-to-date coal-gas plant. Accordingly, 300 tons of "Black Band" coal was shipped. The results from the carbonization of this coal were disappointing as to yield of gas, candle power, and quantity and quality of coke—an indication to the author of the superiority of the oven method of carbonization over the gas-retort with unusually volatile coals. The author also saw the necessity of more closely studying the effect upon the decomposition of hydrocarbons of various methods of oven and gas-retort heating.

The author was asked by financial associates to furnish estimates as to costs of ovens and make recommendations of oven systems. After considering three systems that were being profitably worked in the United States, he was obliged to confess his inability, owing to the inadequacy of reliable

COMPARISONS BYE-PRODUCT OVEN AND GAS-RETORT CARBONIZATION.

TABLE III.—*Comparative Possible Approximate Yields Products, Oven and Gas-Retort Carbonization, per Ton of Coal Carbonized in Ovens* (A) *Heated by Self-Generated Gas,* (B) *Heated by Externally Produced Water or Producer Gas, and* (C) *Gas from Bye-Product Recovery Producers.*

| | Ovens. | | Gas-Retorts. | |
|---|---|---|---|---|
| Products. | Quantity. | Quality. | Quantity. | Quality. |
| (A) Coke | 14 cwt. | High-grade domestic, general steam-raising, locomotive and metallurgical. | 10·4 cwt., being 13 cwt. less 2·6 cwt. for heating. | Porous, of limited application. |
| Tar | 1 cwt. | Good. | 1 cwt. | Inferior to oven tar. |
| Sulphate of ammonia. | 25 lbs. | Good. | 20 lbs. | |
| Benzol | 1·4 gals. | | 0·9 gals. | |
| Cyanogen | 1–1½ lbs. | Prussiate of soda. | 2–4 lbs. | Prussiate of soda. |
| Illuminating gas. | 5,000–6,000 cu. ft. | Good. | 10,000–11,000 cu. ft. | |
| (B) Same as (A) except gas-yield, and use of part of coke. | 10,000–11,000 cu. ft. | | | |
| (C) Same as (A) and (B) except as to sulphate ammonia and tar. | | | | |
| Additional sulphate ammonia, say per 300 lbs. coal for oven-heating gas 9 lbs. | 34 lbs. | | | |
| Additional tar, 1½ gals. | 130 lbs. | | | |

information obtainable in the States, to make any recommendation except that the principle of carbonization in bulk in long narrow chambered coke-ovens with regenerators, and direct uniform heat application, coupled with a simple but efficient system of bye-product recovery that did not too slavishly follow the methods in vogue in ordinary gas-works practice, and that was designed with special reference to the bye-product oven, was absolutely sound when considered as the alternative of the gas-retort system.

The possibility of supplying an important municipality with coke-oven gas from a plant to be erected by the author and associates again brought up the question whether the prevailing oven system in America was after all the best and most efficient with reference to the production of the greatest possible yield of gas. At this juncture, Mr. James W. Ellsworth proposed to the author the joint investigation in Europe of the different bye-product oven and recovery systems, with a view to making certain what were the simplest and most efficient of the systems. The adoption in America of certain European improvements in oven-heating made in Germany satisfied the author that it was essential to a full comprehension of the industrial and financial significance of the bye-product oven to study its gradual development from its source, the causes that led to such development, the consideration of the adequacy of the improvements to the needs revealed by practice, and the ascertainment, by experiment, whether the advances made were really of sufficient financial advantage to discard old and adopt new methods of carbonization.

TABLE IV.—*Estimated Comparative Results, per* 1000 *Cubic Feet, Gas-Oven and Gas-Retort Carbonization, Ovens Requiring, say, One-Half the Gas for Heating, Gas-Retorts Heated with Coke.*

| Products. | Ovens. | | Gas-Retorts. | |
|---|---|---|---|---|
| | | s. d. | | s. d. |
| Coke, say, 1½ cost coal. | 308 lbs. | 2 6 | 111 net lbs., say 1·10 cost of coal | 0 8·7 |
| Tar | 2 gals. | 0 2 | 1 gal. | 0 1 |
| Sulphate ammonia | 5 lbs. | 0 6·4 | 2 lbs. | 0 2·5 |
| Benzol | | 0 3·6 | | 0 1·6 |
| Cyanogen | 1-1½ lbs. per ton (reduced to gas) | 0 1·2 | 2-4 lbs. per ton (reduced to gas) | 0 1·2 |
| | | 3 7·2 | | 1 3·0 |
| | EXPENSES. | | | |
| | s. d. | s. d. | | s. d. |
| Cost of 448 lbs. coal at 12s. per ton | 2 4·8 | | 224 lbs. 1 2·4 | |
| Interest | 0 0·96 | | 0 1·4 | |
| Labour | 0 2·8 | | 0 3 | |
| Maintenance | 0 2·4 | | 0 4 | |
| | | 2 10·96 | | 1 10·8 |
| Oven profit | | 0 8·24 | | |
| Retort deficit | | | | 0 7·8 |

TABLE V.—*Estimated Comparative Results Products, Exclusive of Gas, Oven and Gas-Retort Carbonization, per Ton of Coal Carbonized and per* 1000 *Cubic Feet of Gas Respectively :—*

| Products. | Per Ton of Coal. | | Per 1000 Cubic Feet Gas. | |
|---|---|---|---|---|
| | Oven. | Gas-Retort. | Oven. | Gas-Retort. |
| | s. d. | s. d. | s. d. | s. d. |
| Coke | 12 4 | 7 3 | 2 6 | 0 8·7 |
| Tar | 1 0 | 9 | 2 | 1 |
| Sulphate ammonia | 2 8 | 2 3 | 6·4 | 2·5 |
| Benzol | 1 6 | 1 0 | 3·6 | 1·6 |
| Cyanogen | 6 | 1 0 | 1·2 | 1·2 |
| | 18 0 | 12 3 | 3 7·2 | 1 3·0 |
| Cost of coal | 12 0 | 12 0 | 2 4·8 | 1 2·4 |
| Interest | 4·8 | 1 2·4 | 0·96 | 1·4 |
| Labour | 1 2 | 2 4 | 2·8 | 3·0 |
| Maintenance | 1 0 | 3 4 | 2·4 | 4 |
| | 14 6·8 | 18 10·4 | 2 10·96 | 1 10·8 |
| | | s. d. | | s. d. |
| Oven profit | | 3 5·2 | .. | 0 8·24 |
| Retort deficit | | 6 7·4 | .. | 0 7·80 |

TABLE VI.—*Actual Labour Costs, Oven and Retort Carbonization, per ton of Coal Carbonized—England, Germany, and Belgium Ovens—England and Germany Retorts, Average Practice,* 400 *Tons Coal per* 24 *hours.*

| Ovens. | | | Gas-Retorts. | |
|---|---|---|---|---|
| England. | Germany. | Belgium. | England. | Germany. |
| 8d. to 10d. | 5·84d. | 6·5d. | s. d. 2 4 | s. d. 2 2·5 |

TABLE VII.—*Analysis of Labour as to Men and Labour Hours Oven (Capacity* 6½ *Tons each), Oven and Gas-Retort Carbonization,* 400 *and* 650 *Tons Daily, Exclusive of Unloading, Bye-Product, and Maintenance Labour, Based on Modern Practice.*

| 400 Tons. | | | | 650 Tons. | | | |
|---|---|---|---|---|---|---|---|
| No. of Men. | | Labour Hours. | | No. of Men. | | Labour Hours. | |
| Ovens. | Retorts. | Ovens. | Retorts. | Ovens. | Retorts. | Ovens. | Retorts. |
| 34 | 75 | 408 | 900 | 42 | 120 | 504 | 960 |

TABLE VIII.—*Comparative Labour Hours per Ton Coal Carbonized per* 24 *Hours, Oven and Gas-Retort Carbonization, Excluding Unloading, Bye-Product, and Maintenance Labour.*

| 400 Tons. | | 650 Tons. | |
|---|---|---|---|
| Ovens. | Gas-Retorts. | Ovens. | Gas-Retorts. |
| 1·04 hours. | 2·25 hours. | 1·05 hours. | 2·2 hours. |

TABLE IX.—*Analysis of Actual Labour Employed and Costs of Oven and Gas-Retort Carbonization per* 24 *Hours (Three Shifts England),* 400 *Tons Coal per Day.*

**OVENS.**

| — | No. of Men. | Price per Day. | Wages per 24 Hours. |
|---|---|---|---|
| | | s. d. | £ s. d. |
| 3 shifts, each shift requiring :— | | | |
| 1 engineer for charging machine | 3 | 5 3 | 0 15 9 |
| 1 help | 3 | 4 11 | 0 14 9 |
| 1 attending to winches for lifting doors | 3 | 4 10 | 0 14 6 |
| Attending to loading of charging machine (*see* ram man) | | | |
| Atttending to gas-main | 12 | 4 5 | 2 13 0 |
| Engineer for coke-pusher (*see* ram man) | | | |
| For luting doors of ovens | 6 | 2 6 | 1 4 9 |
| | 3 | 3 3 | |
| For quenching the coke | 6 | 4 5 | 1 18 6 |
| | 3 | 4 0 | |
| For attention to gas-burners | 3 | 4 9 | 0 14 3 |
| For general work | 9 | 4 0 | 1 16 0 |
| For coke-charging bunker | 10½ | 5 6 | 2 17 9 |
| Foreman | 3 | 8 0 | 1 4 0 |
| | | | £14 13 3 |

Cost per ton of coal carbonized (three shifts) . **8·8d.**

**RETORTS.**

| — | No. of Men. | Wages per 24 Hours | Pence per Ton of Coal. | — |
|---|---|---|---|---|
| | | £ s. d. | d. | |
| Machine attendants | 12 | 3 18 0 | 2·23 | Charging and discharging machines, equal numbers. |
| Retort-lid openers and shutters | 6 | 1 16 0 | 1·03 | |
| * Coke-spreaders | 30 | 7 2 6 | 4·07 | Quenching and throwing back coke into retort-house store. |
| Firemen, including pokers in and pluggers | 24 | 6 8 6 | 3·67 | |
| Lidman | 1 | 0 5 6 | 0·16 | Setting levers, and stopping leaks in retort lids. |
| Proportion of engine and boiler men | 1 | 0 7 10 | 0·22 | Supplying power to machinery. |
| General work (scurfers, flue cleaner and handymen) | 6 | 1 14 6 | 0·99 | |
| Pipe cleaners and auger men | 15 | 4 10 6 | 2·59 | Ascension pipes. |
| Foreman | 3 | 1 2 6 | 0·64 | Superintendent. |
| | | £27 5 10 | 15·59 | |

Cost per ton of coal carbonized (three shifts) . . . . **16·4d.**

* Where coke conveying machinery is installed these men are replaced by six others costing in all 30s. per day = 0·80 pence per ton of coal.

TABLE X.—*Estimated Men and Labour Hours per Ton of Coal Carbonized per 24 Hours, 60 and 100 Ovens, due to Increased Carbonizing Capacity Ovens to 10 Tons each per 24 Hours, as compared with Results shown in* TABLES VII. *and* VIII.

| 60 Ovens. | | | 100 Ovens. | | |
|---|---|---|---|---|---|
| No. of Men. | Total Labour Hours. | Labour Hours per Ton of Coal. | No. of Men. | Total Labour Hours. | Labour Hours per Ton of Coal. |
| 38 | 408 | 0·76 | 50 | 625 | 0·625 |

TABLE XI.—*Labour Hours Ovens of Koppers (England), Coppée (Belgium), and Collin (Germany) per Ton of Coal Carbonized per 24 Hours 50 Ovens Koppers, 270 Tons, and 60 Ovens Coppee and Collin, 400 Tons respectively.*

| Koppers. | Coppée. | Collin. |
|---|---|---|
| 1·5 hours | 1·2 | 1·02 |

TABLE XII.—*Comparative Capital and Interest Costs Oven and Gas-Retort Carbonization.*

| Ovens. | Gas-Retorts. |
|---|---|
| (1) Ovens and connections, charging and discharging machinery, &c. | (1) Retorts with regenerators, charging machines, pushers, and other automatic machinery. |
| (2) Bye-product plant, &c. £100 to £200 per ton coal carbonized. | (2) Bye-product plant. £200 to £300 per ton of coal carbonized. |

*Note.*—There is such a wide variation between modern plants in England and Germany, that the basis of interest charges, while relative, can only at best be approximate.

### THE BYE-PRODUCT OVEN COAL PRODUCTS INDUSTRY.

It would be instructive, had we the time, to consider the growth, stability, and profitableness of this branch of carbonization. While the birthplace of the modern retort-oven is Belgium and bye-product ovens were produced in other places, it was in Germany that an important and far-reaching industry was established that has exerted a great influence on coal and iron undertakings the world over, and is destined to do likewise in the gas industry, the author firmly believes.

TABLE XIII.—*Estimated Yearly Operations Modern Bye-Product Recovery Coke Works (Self-Generated Oven Gas for Heating), Carbonizing Capacity 5000 Tons Daily, not including Coke, Gas, and Coal.*

YEARLY ESTIMATED RECEIPTS.

| | £ |
|---|---|
| 1,200,000 tons high-grade coke | — |
| 17,000,000 gallons tar at 1d. per gallon | 70,833 |
| 19,000 tons sulphate of ammonia at £12 per ton | 228,000 |
| 2,380,000 gallons benzol, being a portion only of benzol contents at 9d. per gallon | 89,250 |
| 5,100,000 lbs. prussiate of soda at 4d. per lb. | 85,000 |
| 10,000,000,000 cubic feet gas | — |
| | £473,083 |

YEARLY ESTIMATED EXPENDITURE.

| | £ |
|---|---|
| 1,700,000 tons coal | — |
| Labour and supervision at 1s. per ton | 85,000 |
| Purification gas | 36,000 |
| Sulphuric acid at 15s. per ton | 14,250 |
| Vitriol 6830 tons at 32s. per ton | 10,928 |
| Interest, &c., 4·8d. per ton | 34,000 |
| Maintenance, &c., 1s. per ton | 85,000 |
| Approximate profit | 207,905 |
| | £473,083 |

### THE ART OF OVEN BUILDING.

The art of oven building requires for its successful prosecution varied engineering, chemical, and constructive skill, only obtainable after a long apprenticeship under varying conditions. In a preliminary report that the author sent to America, he stated that, even if all the coal tests were satisfactory and an oven had been found that showed the highest efficiency, the question of construction with the labour and materials of a given country were grave questions. Take, for instance, the question of refractory materials. Tens of thousands of pounds have been spent by the different oven-builders in experimentation with mixtures of fire-clays; some builders, more venturesome than others, in departing from well-established standards, suffering great financial losses. Safety only lies in entrusting the building of ovens to well-established responsible builders of long experience.

### MODERN BYE-PRODUCT OVENS.

The author will accordingly confine himself to the oven systems of relatively large gas yield that he now regards worthy of consideration in connection with gas-making,

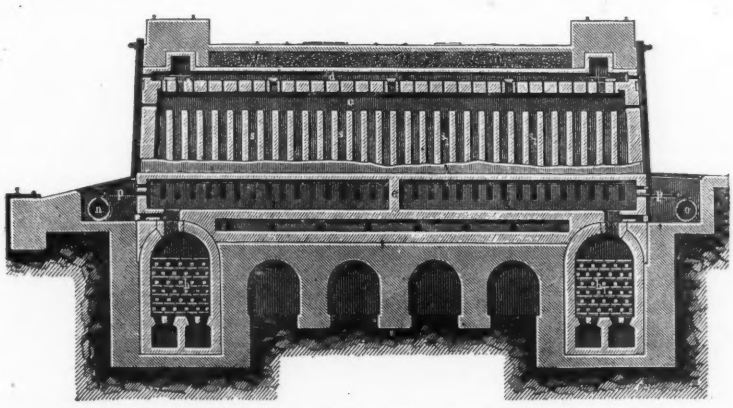

**Fig. 1.—Otto-Hoffmann Regenerative Oven.**

dealing rather with principles embodied than with details which would unnecessarily tax your attention. The Otto-Hoffmann, shown in fig. 1 (an improvement of the original Coppée oven), came into notice in 1881, and owes its important place among bye-product ovens to being the first to adopt the Siemens regenerative principle. Notwithstanding inefficient heating methods, it made for itself an enviable record as the leading bye-product oven of its time. It has been abandoned by its constructors, Dr. C. Otto and Co.—owing to acknowledged defects in the principle of its construction, more especially due to the alternate application of heat to one-half the oven, from which result half-hourly fluctuations in temperature which strain the brickwork and disadvantageously affect the carbonization process.

In 1894, Mr. G. Hilgenstock, the General Manager of Dr. C. Otto and Co., brought out the bottom-fired oven known generally as the Otto-Hilgenstock oven, the salient feature of which is the use of bunsen burners throughout the whole length of the oven wall to secure a more uniform distribution of heat—abandoning the Siemens regenerator, and using the sole flue of the oven as a recuperator for preheating the gas and air. In fig. 2 is shown the Otto regenerative oven (1905), in which this principle is embodied and combined with a modified double regenerator system. The fundamental characteristics of the oven are the following: (*a*) The regenerators are longitudinally disposed under the charging and discharging wharves. (*b*) The reversal periodically takes place in two alternate sections, each equalling one-quarter of the whole length of the side-wall of the oven, which is divided by 32 vertical flues, the gas rising in eight flues of a section at a time and descending in the next adjoining eight. (*c*) The regenerators are double, both in front and in the rear; one set being of refractory, the other of ordinary red brick.

The United-Otto oven, built in the United States, embodies certain features of the old Otto-Hoffmann as well as the new Otto-Hilgenstock under-fired principle. The oven foundations are more accessible than those of the Otto (1905),

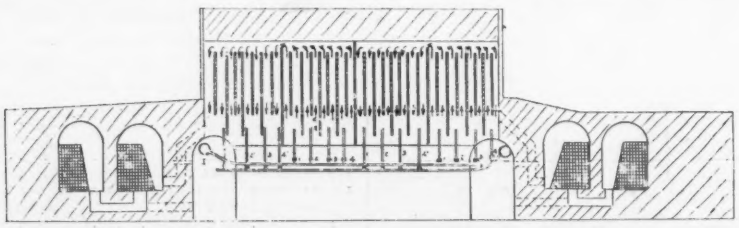

Fig. 2.—Otto (1905) Regenerative Oven.

and while permitting readier inspection without discomfort to the workmen, retain the Otto-Hoffmann half-oven reversal abandoned by Dr. C. Otto and Co. The regenerators, instead of being outside, are underneath the ovens. Fig. 3 shows the side of this oven and the method of heat distribution.

The Koppers Regenerative Oven (1905) is shown in fig. 4. Under each oven there are two regenerators placed alongside one another, each occupying one-half the length of the oven. Each of these regenerators works separately, and regenerates the heat absorbed from the products of combustion coming from that portion of the oven above the same. Rising from the lower portion of the side-wall are 30 vertical flues. The gas entering at the base of the flues burns on a level with the sole; combustion being supported by the hot air coming from the regenerators. The vertical divisions that separate the flues start at the point of distribution of the gas, thus making the separation of the flues from one another absolute. Over the vertical flues is a horizontal canal, common to all the flues, into which the products of combustion are discharged. Corresponding to each flue are separate chimneys, through which regulation of draught and access for cleaning are made possible.

The Coppée regenerative oven shown in fig. 5 has 30 flues distributed along each side-wall. The general characteristics are the following: (*a*) The regenerators are placed longitudinally under the oven battery. (*b*) The side-walls are heated in consecutively alternating sections, each equal to the tenth part of their length, by the products of combustion that rise in the three first flues and descend in the adjoining three, and so on. (*c*) Before passing into the regenerators, the products of combustion of all the ovens are admitted into a collecting canal, so that the regenerators are traversed throughout their entire length by all the products of combustion.

The new Collin regenerative oven is shown in fig. 6. Its general characteristics are the following: (*a*) Simultaneous direct heating of the entire side-wall of the oven by means of twenty-eight vertical main flues and twenty-six auxiliary flues; the products of combustion rising in the main vertical flues and descending the contiguous auxiliary flues. (*b*) A reversal of the draught simultaneously in all the twenty-eight flues from the top downward, heated air rising through the auxiliary flues and meeting gas at the top of the main flues, combustion occurring below the upper portion of the oven charge, the products descending through the main flues. (*c*) The admission at the bottom and top of the oven of gas to different sections, each admission port, independent of the others, making it possible to regulate with ease the supply of gas to every section of the oven from each of its ends at the bottom and top of the side wall.

### Comparison of Otto, United-Otto, Koppers, Coppée, and New Collin Regenerative Ovens.

In properly estimating the relative economic values of bye-product oven systems as efficient carbonizing agents, the following factors, it seems to the author, must be taken into account, assuming equal durability and simplicity of construction.

1.—Cost of carbonization per unit of capital, labour, and maintenance charges per ton of coal carbonized.
2.—Net gas yield.
3.—Quantity of coke and other products.
4.—Quality of products.

In comparing the five systems, it is found that they are all characterized by long, narrow coking-chambers with vertical flues in the side-walls, through which the heat for carbonization is more or less effectively applied; the air for combustion in all cases being supplied hot, by means of regenerators heated alternately by combustion products. By a process of elimination, it will be possible to quickly arrive at the salient features of each of these systems.

To correct the admitted defects of the Otto-Hoffmann system of heating, Koppers predetermines the size of the admission ports to each flue, and provides a series of ingenious dampers designed to regulate the flow of combustion products through each flue. These dampers are actuated from the top of the oven. They are manipulated by lifting an iron cover to a small chimney or well, located over each vertical flue, designated A in fig. 4. To uniformly regulate the draught in all the 32 flues of each side-wall, it is necessary to lift 32 covers in each side-wall, and adjust each damper periodically during the coking period. The wide differences in temperature by directly heating one-half of the oven and indirectly heating the other half, which was one of the chief objections to the Otto-Hoffmann, still exist to a considerable extent in the Koppers modification.

In the Otto, Coppée, and Collin ovens there is recognized the desirability for simple and positive means of maintaining

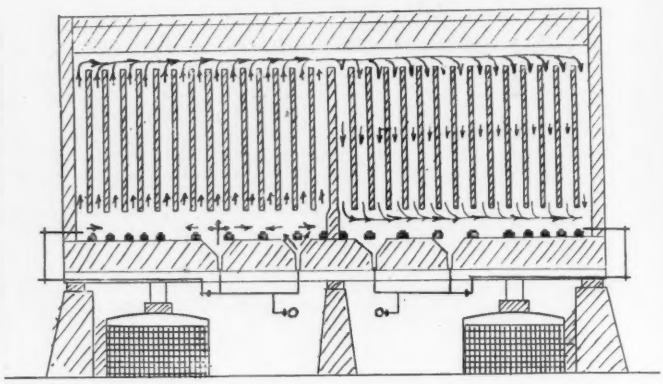

Fig. 3.—United Otto Regenerative Oven.

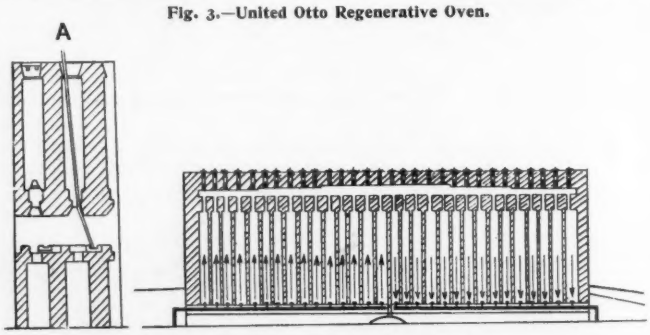


Fig. 4.—Koppers Regenerative Oven.

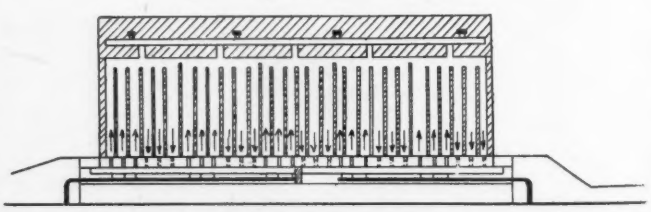

Fig. 5.—Coppée Regenerative Oven.

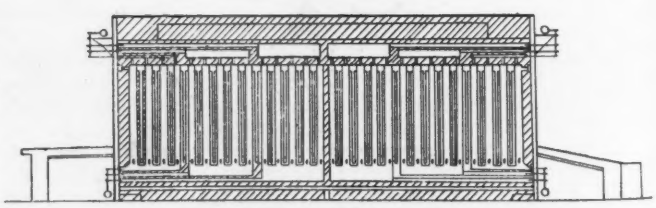

Fig. 6.—New Collin Regenerative Oven.

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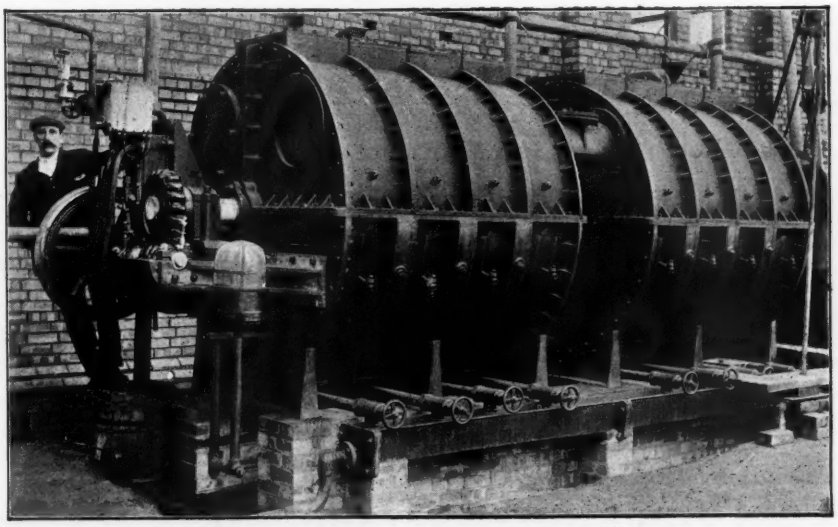

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the temperature of the side-walls along their entire length as uniform as possible, and to avoid the disadvantageous fluctuations that must result from the heating directly of only one-half of the oven. In the Otto (1905) oven, this recognition is put into practical form by the adoption of the Hilgenstock under-flame method, and the reversal of the heat in every other series of eight consecutive flues. Coppée recognizes it in a reversal in every second series of three consecutive flues, and Collin in all of his 28 main flues, aided by 26 auxiliary flues. The United-Otto Company, while preserving the reversal method abandoned by Dr. C. Otto and Co., has embodied in it the underfired principle of Hilgenstock, with differently disposed regenerators.

If the effort of Otto and Coppée to impart heat uniformly to the oven charge along its entire length through the side wall is the standard to be attained, Collin has more nearly attained this in his new oven than any other builder. Coppée and Otto follow. It is not meant to imply that with the Koppers oven good results cannot be attained; but it would not seem that it can be done with the same ease, and with the same return for capital, labour, and maintenance costs possible with the systems named.

Figs. 7 to 10 are intended to graphically represent the distribution of the heat to the oven-walls, and therethrough to the charge of coal; the diagonally shaded portions indicating the section or sections of the oven directly heated by the combustion therein of the gases, the nearly spent products descending the unshaded portion. There is a variation of heat absorption in every section of the oven, unless provision is made for its regulation. Moreover, the alternation of the draught every half hour from the section or sections represented by the diagonally shaded part or parts to that represented by the unshaded results in more highly heating the charge in contact with the interior of such portions of the wall section that the hotter gases impart their heat to, and strains the brickwork and unfavourably affects carbonization. The diagrams show such heating of the oven-wall in sections: One-half directly and one-half indirectly in Otto-Hoffmann, United-Otto, and Koppers ovens; two quarter sections directly and two indirectly in Otto (1905) ovens; five one-tenth sections directly and five indirectly in Coppée regenerative; and twenty-eight sections directly and twenty-six sections indirectly in new Collin regenerative ovens.

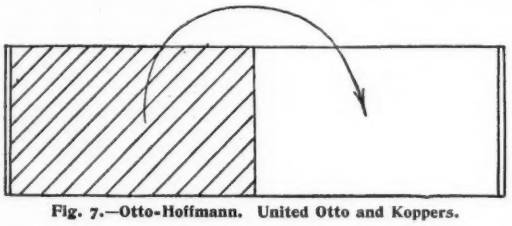


Fig. 7.—Otto-Hoffmann. United Otto and Koppers.

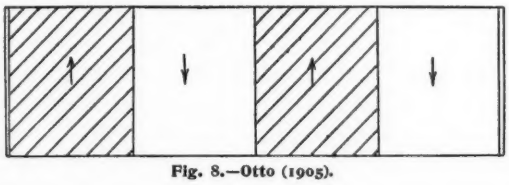


Fig. 8.—Otto (1905).

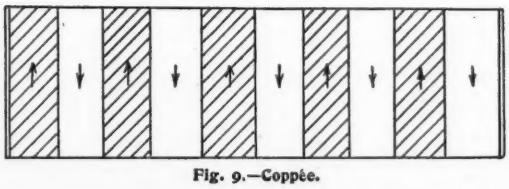


Fig. 9.—Coppée.

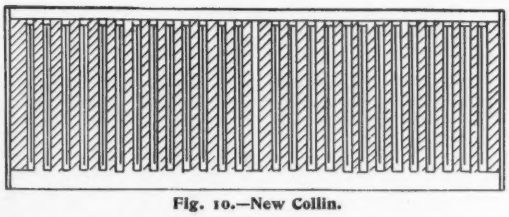


Fig. 10.—New Collin.

Diagrams Showing the Distribution of Heat to the Oven Walls.

Actual tests with the same coal, under the same circumstances, in the presence of disinterested authorities, the author believes, should be made in the oven systems named before an ultimate decision is reached as to superiority of any one oven system over another, taking into account the factors set up as standards. Meanwhile, he has placed before you figures based upon known bye-product results that will serve to develop the various questions that are involved in the matters under consideration.

### Bye-Product Oven Gas Production in the United States.

Oil enrichment became year by year so much more expensive in the United States that eventually the cost of water gas approached twice and occasionally thrice times as much as when the system was first adopted. This tendency led to the economic reconsideration of carbonization some twelve years ago by Mr. Henry M. Whitney, of Boston, the organizer of the New England Gas and Coke Company. After taking the best counsel obtainable, and employing engineers to study the subject at home and abroad, he decided to carbonize Canadian coal in the then only modern bye-product ovens of substantial gas yield. At Everett, Massachusetts, just outside Boston, 400 ovens were erected to supply the various companies in Boston and the vicinity with illuminating gas to the extent of their requirements. Mr. Emerson M'Millin gave the undertaking his engineering sanction in becoming interested therein, as well as later in the United Coke and Gas Company, the constructors of the ovens. These ovens—the Otto-Hoffmann—had previously been used for making metallurgical coke, and did not give the yield of gas that the Company's subsequent United-Otto ovens made possible. The able and elaborate paper of Dr. F. Schniewind, of New York, read before the International Engineering Congress in 1901, gives the fullest particulars concerning this installation. Nearly all the illuminating gas for the City of Baltimore is now made in bye-product ovens. Some 20 towns are supplied from Camden, N.J., with gas made in ovens, and many companies are studying the subject very seriously.

### The Author's Preliminary Studies.

On behalf of Mr. James W. Ellsworth, of New York, an important colliery owner, the author had to do with a series of tests conducted at Otto, Pennsylvania, in Otto-Hoffmann ovens, for the Maryland Steel Company, to determine the availability of the coal of the Ellsworth collieries, located at Ellsworth, Washington County, Pennsylvania, for the production of high-grade coke and illuminating gas. This coal the author was instrumental in having extensively used by the Consolidated Gas Company of New York. It had been previously used only as a steam coal. Its possibilities as a gas coal were first fully revealed by the product oven.

Shortly after this Otto test, early in 1903, the author received a call from Professor Lowe, deservedly known as the "Father of Water Gas" in the United States. The Professor's practical mind had clearly seen the necessity of, in some way, introducing a compensating factor for the fluctuating and costly oil-enrichers. His remedy was the simultaneous production of an anthracitic coke for domestic purposes, and a mixed coal and water gas. A new oven system of his invention was then in course of erection at Rockaway Park, New York, in connection with the water-gas works existing there. The author had 300 tons of Ellsworth coal coked in this new oven, of which the general principle as to heating was that of the bee-hive oven. High temperatures, however, were to be maintained, in order to shorten the coking period. Steam was periodically injected into the mass of coke for producing water gas to mix with the coal gas evolved as cokification proceeded; oil being supplied to enrich the resultant mixed gases, which passed into a superheater for fixation. The coke was of excellent quality for metallurgical and domestic purposes; but, owing, it was said, to defects of construction, natural in a system so radical, the gas results were inconclusive.

The author mentions this circumstance to show the tendency of a gas pioneer whose gas-making system has become world-renowned. Professor Lowe saw that the production of an improved solid fuel by gas companies already successful exploiters of gaseous fuel, would result in the financial improvement of the gas business. The Professor felt what

was then in the air in America, as it is now in the air in Europe—the recognition on the part of gas companies of the advantages of carbonization in bulk and the substitution of a high-grade for a low-grade solid fuel in their list of commodities.

### Twenty Years Ago and To-Day.

When one contrasts the gas companies of twenty years ago in America and Europe with those existing to-day, one cannot fail to be much impressed. In those good old days they were self-contained and dignified autocrats that the public feared, whose business was shrouded in mystery. To-day they are alert purveyors of public commodities, advertising their products with the rarest ingenuity, public teachers of the arts of cooking and heating, propagandists of hygiene, and purifiers of city atmospheres. Illustrated tracts betraying no uncommon literary skill abound in reception and counting rooms; and as one passes into their executive offices, bright coloured stoves and lamps and fixtures of every known design for the utilization of their products are seen on exhibition.

### Bye-Product Oven Cokes.

Evaporative tests carried on by the author, aided by careful testing engineers, with coke for steam-raising purposes have satisfied him that, with proper provision for burning coke scientifically, a much greater useful effect can be produced than with the best American anthracite. It is confidently expected that coke suitable for open fires, locomotives, and metallurgical purposes can also be made by varying the coking period in England. In Germany, the basis for determining coke values is to multiply the value of the coal by 1·6, adding 2s. 2½d. for expenses. This standard has been maintained for years.

### Sulphate of Ammonia and Other Products.

The agricultural needs for sulphate of ammonia would not be met if every gas company doubled its output; and tar distillates are in greater demand to-day than ever. Benzol is now being used as a diluent of spirit for motor and illuminating purposes. A bye-product oven undertaking, therefore, permits the making of very large discounts from estimates.

### The Art of Oven Bye-Products Recovery.

The profitableness of the oven bye-product recovery systems did not contribute to the stimulation of invention until competition stepped in and induced oven builders to undertake a simplification of hitherto costly and not altogether satisfactory methods. Evence Coppée, Dr. C. Otto and Co., the Otto-Hilgenstock Company, have recently done this; but among the more recent improvements that have been thoroughly tested are those of Mr. George Wilton, the Managing-Director of the Chemical Engineering Company, London. These improvements, generally considered, consist of a simple system of bubbling weirs, hydraulic valves that effectually prevent leakage during interval of re-charging oven, multitubular coolers, and condenser-washers. The hydraulic valve also prevents the fixed ammonia becoming mixed with the tar. The bubbling weirs are of cast iron and interchangeable. They are all alike, and there are no moving parts. Mr. Wilton is sanguine in the belief that he has solved the problem of cheaply making sulphuric acid from the sulphur in the coal carbonized. This will be a source of great economy.

### Present Financial Status of Bye-Product Oven Gas Production Undertakings.

It was not until two years ago that gas financiers in the United States became fully convinced of the stability and profitableness of the bye-product oven method of carbonization for gas production. The author took up the matter with the heads of important gas companies in several large cities some three years ago, and the only valid objection raised was the necessity of creating a demand for the improved coke. When such objections were made, the author invariably made proposals to erect a bye-product plant, and to furnish gas at 33⅓ per cent. less than they were producing it for, providing they made a contract for a period sufficiently long to warrant his financing the proposition. But in every case the result was a decision to hold the matter in abeyance, and see if they were not perhaps warranted, under the circumstances, in taking the risk themselves and giving him the opportunity of securing the contract. The application of strict financial and industrial methods to the solution of the problem of bye-product oven carbonization in many places in the United States shows that the objections to it are even more foundationless than those made to water gas by eminent gas authorities at the time of its advent.

The modern bye-product oven—that giant nephew of its hundred-year-old dwarf of an uncle, the gas-retort—has already become a potent factor in the gas industry of America, and will have to be reckoned with in Europe hereafter. Several important projects are now on foot. The firm of F. J. Collin, of Dortmund, are building an illuminating bye-product gas-plant for the Krupp Works, at Essen; the gas to be of ample luminosity to be burned in open burners, as mantles, owing to the vibration at the works, are impracticable. At Bargoed, Wales, illuminating gas is being made in bye-product ovens. Prominent gas companies within a twelvemonth in England, Germany, France, and Belgium have put their managers and engineers to work studying the problem.

The author has endeavoured to take the members of the Institution unreservedly into his confidence in showing the conditions that gave rise to his preliminary studies, the circumstances leading to his present investigations, and the foundation for his belief that the satisfactory solution of this large question of carbonization is near at hand; and he trusts that good may result from his contribution to the agitation of a subject that, judging from to-day's programme, is a question of moment. To the several members of this body who have treated him with such whole-hearted generosity, to his indulgent hearers who honour him with their attention, and to the Technical Press that has in such a kindly manner noticed his efforts while in this country, he begs to proffer his sincerest thanks.

## Appendix.

*Gas Produced during Each Hour.*

| Hour after Charging. | Total Cubic Feet. | Per 2000 lbs. Observed | Per 2000 lbs. Corrected O° C., 760 mm. | Hours after Charging. | Total Cubic Feet. | Per 2000 lbs. Observed. | Per 2000 lbs. Corrected O° C., 760 mm. |
|---|---|---|---|---|---|---|---|
| 1 | 3580 | 549·3 | 488·3 | 15 | 3110 | 477·2 | 422·8 |
| 2 | 3600 | 552·4 | 487·8 | 16 | 2950 | 452·7 | 401·0 |
| 3 | 3790 | 581·6 | 513·6 | 17 | 2900 | 445·0 | 394·2 |
| 4 | 3590 | 550·9 | 483·3 | 18 | 2830 | 434·2 | 384·7 |
| 5 | 3330 | 511·0 | 448·2 | 19 | 2830 | 434·2 | 384·7 |
| 6 | 3210 | 492·6 | 427·9 | 20 | 3090 | 474·2 | 421·5 |
| 7 | 3120 | 478·8 | 425·6 | 21 | 3040 | 466·6 | 414·7 |
| 8 | 3060 | 469·6 | 406·4 | 22 | 2920 | 448·0 | 398·3 |
| 9 | 2960 | 454·1 | 395·9 | 23 | 2870 | 440·3 | 390·1 |
| 10 | 3100 | 475·7 | 414·6 | 24 | 2820 | 432·7 | 380·8 |
| 11 | 2960 | 454·1 | 397·1 | 25 | 2490 | 382·0 | 336·2 |
| 12 | 2840 | 435·8 | 382·3 | 25–40 | 610 | 93·7 | 82·4 |
| 13 | 2840 | 435·8 | 384·9 | Tests . | 1000 | 153·4 | 135·2 |
| 14 | 2900 | 445·0 | 394·2 | Totals . | 78,340 | 12,021·0 | 10,597·9 |

*Illuminating Value.*

[Gas volume 5 cubic feet, at O°C. and 760 mm., with and without $CO_2$.]

| Time. | Candle Power with $CO_2$ (Iron Purified). | Per Cent. of $CO_2$. | Candle Power, no $CO_2$ (Calculated). | Time. | Candle Power with $CO_2$ (Iron Purified). | Per Cent. of $CO_2$. | Candle Power, no $CO_2$ (Calculated). |
|---|---|---|---|---|---|---|---|
| 0·40 | 21·60 | 4·6 | 25·05 | 11·05 | 15·59 | 4·8 | 19·19 |
| 1·00 | .. | 4·6 | .. | 11·35 | 15·18 | 4·8 | 18·78 |
| 1·05 | 22·96 | 4·6 | 26·41 | 12·05 | 14·68 | 4·9 | 18·35 |
| 1·35 | 22·74 | 4·7 | 26·19 | 12·35 | 14·10 | 4·9 | 17·77 |
| 2·00 | .. | 4·7 | .. | 13·00 | .. | 4·9 | .. |
| 2·05 | 22·31 | 4·7 | 25·83 | 13·05 | 13·59 | 4·9 | 17·26 |
| 2·35 | 22·09 | 4·7 | 25·61 | 13·35 | 12·98 | 4·9 | 16·65 |
| 3·05 | 21·63 | 4·7 | 25·15 | 14·05 | 12·37 | 4·8 | 15·97 |
| 3·35 | 21·12 | 4·7 | 24·64 | 14·35 | 11 54 | 4·7 | 15·14 |
| 4·00 | .. | 4·7 | .. | 15·05 | 10·73 | 4·7 | 14·25 |
| 4·05 | 20·40 | 4·7 | 23·92 | 15·35 | 9·95 | 4·6 | 13·40 |
| 4·35 | 20·04 | 4·7 | 23·56 | 16·00 | .. | 4·5 | .. |
| 5·05 | 19·53 | 4·7 | 23·05 | 16·05 | 9·04 | 4·5 | 12·41 |
| 5·35 | 19·30 | 4·7 | 22·82 | 16·35 | 8·12 | 4·4 | 11·42 |
| 6·00 | .. | 4·7 | .. | 17·05 | 7·71 | 4·3 | 10·93 |
| 6·05 | 18·99 | 4·7 | 22·51 | 17·35 | 7·31 | 4·2 | 10·46 |
| 6·35 | 18·67 | 4·7 | 22·19 | 18·05 | 6·80 | 4·1 | 9·87 |
| 7·05 | 18·41 | 4·6 | 21·86 | 19·00 | .. | 3·9 | .. |
| 7·35 | 18·20 | 4·6 | 21·65 | 19·05 | 6·29 | 3·9 | 9·21 |
| 8·00 | .. | 4·6 | .. | 20·05 | 5·81 | 3·8 | 8·66 |
| 8·05 | 18·20 | 4·6 | 21·65 | 21·05 | 4·69 | 3·8 | 7·54 |
| 8·35 | 17·75 | 4·7 | 21·27 | 22·00 | .. | 3·8 | .. |
| 9·05 | 17·34 | 4·8 | 20·94 | 22·05 | 3·97 | 3·8 | 6·82 |
| 9·35 | 16·93 | 4·8 | 20·53 | 22·35 | 2·75 | 3·6 | 5·45 |
| 10·00 | .. | 4·8 | .. | 23·05 | 1·83 | 3·4 | 4·38 |
| 10·05 | 16·63 | 4·8 | 20·23 | 25·00 | .. | 2·8 | .. |

*Gas Analysis.*

| Hours after charging | 1. | 2. | 4. | 6. | 8. | 10. | 13. | 16. | 19. | 22. | 25. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Illuminants | 7·8 | 6 9 | 5·8 | 5·4 | 5·0 | 4·4 | 4·0 | 3·5 | 2·4 | 1·8 | 0·9 |
| Marsh gas | 46·9 | 42·9 | 39·9 | 36·5 | 34·9 | 32·8 | 27 4 | 25·6 | 23·3 | 19·7 | 17·7 |
| Hydrogen | 25·0 | 30 0 | 34·3 | 38·6 | 40·9 | 43·0 | 47·4 | 48·9 | 54·6 | 61·2 | 65·0 |
| Carbon monoxide | 6·4 | 6·3 | 5·9 | 5·9 | 5·7 | 6·4 | 7·0 | 7·1 | 7·0 | 6·5 | 6·3 |
| Carbon dioxide | 4·6 | 4·7 | 4·7 | 4·7 | 4·6 | 4·8 | 4·9 | 4·5 | 3·9 | 3·8 | 2 8 |
| Oxygen | 0·3 | 0·4 | 0·3 | 0·4 | 0·4 | 0 3 | 0·2 | 0·3 | 0·3 | 0·2 | 0·2 |
| Nitrogen | 9·0 | 8·8 | 9·1 | 8·5 | 8·5 | 8·3 | 9·1 | 10·1 | 8·5 | 6·8 | 7·1 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| Calorific value, B.Th.U. | 805·2 | 756·7 | 710·4 | 678·9 | 658·9 | 631·0 | 580·5 | 554·2 | 551·1 | 488·6 | 457·0 |

*Illuminating Value of Surplus Gas (with $CO_2$) per 2000 lbs. of Dry Coal.*

| Hours after Charging. | Cubic Feet. | Average Candle Power. | Candle-Feet. |
|---|---|---|---|
| 1 | 488·3 | 22·28 | 10,879·3 |
| 2 | 487·8 | 22·67 | 11,058·4 |
| 3 | 513·6 | 22·01 | 11,304·3 |
| 4 | 483·3 | 21·05 | 10,173·5 |
| 5 | 448·2 | 19·99 | 8,959·5 |
| 6 | 427·9 | 19·27 | 8,245·6 |
| 7 | 425·6 | 18·69 | 7,954·5 |
| 8 | 406·4 | 18·27 | 7,424·9 |
| 9 | 395·9 | 17·76 | 7,031·2 |
| 10 | 414·6 | 16·97 | 7,035·8 |
| 11 | 397·1 | 16·11 | 6,397·3 |
| 12 | 382·3 | 15·15 | 5,791·8 |
| 12·07 | 47·2 | 14·68 | 692·9 |
| Totals and Average .. | 5318·2 | 19·36 | 102,949·0 |

## NOTES ON THE USE OF EXCESS GAS FROM BYE-PRODUCT COKE-OVENS FOR LIGHTING AND POWER PURPOSES.

**By C. E. RHODES, of Rotherham.**

There is great variation of opinion as to the merits of the vertical as against the horizontal-flued retort coke-oven; but it is now generally agreed that the vertical-flued oven with regenerator provides more surplus gas for lighting and power purposes than any other type of oven. The following particulars are taken from the actual working results of two batteries of ovens.

### Horizontal-Flued Ovens.

At the plant in question, there are 65 horizontal flue Simon-Carvès ovens. Of these ovens, 35 were put in operation in 1902, and are of the old type, with one series of flues common to two ovens; while 30 more started work in 1904, and are of the new type, with horizontal flue having a solid mid-wall and a series of separate small flues for each oven. The advantage of the latter type is very marked; the 30 newer ovens producing half the total output of coke of the whole battery, which for the past twelve months has averaged 1391 tons per week. The yield of saleable coke is no less than 67 per cent.; and to this must be added 2 per cent. of breeze and dust, which, of course, has produced its quota of gas. The total quantity of clean (after washing) coal carbonized during the twelve months has been 98,512 tons; the following being an analysis of the washed coal:—

| | Per Cent. |
|---|---|
| Volatile matter | 28·55 |
| Fixed carbon | 63·65 |
| Ash | 7·80 |
| | 100·00 |

The coal coked is produced from two seams—the Parkgate and the Barnsley, which contain 30·77 per cent. and 30·97 per cent. of volatile matter respectively; the analysis being made on the samples representing the whole of the seams. The coal coked, however, is only the small coal, which is screened through meshes $\frac{3}{8}$-inch diameter after being washed; and its volatile matter averages 28·55 per cent., being about $2\frac{1}{2}$ per cent. less than that of the average of the two seams. Analyses made of the whole of the two seams for gas-making purposes show that the coals yield between 10,000 and 11,000 cubic feet of gas per ton.

A meter was fitted to the coke-ovens; and after a week's trial it showed that 9000 cubic feet of gas was produced per ton of coal carbonized, after making due allowance for moisture. A later trial was made upon the quantity of excess gas after the whole of the requirements of the ovens for heating purposes had been satisfied; and this showed that 1750 cubic feet of gas per ton of coal, or 19·4 per cent., was to spare for steam-raising and other purposes. The calorific value of this gas is 400-450 B.Th.U. per cubic foot; and its analysis is as follows:—

| | Per Cent. |
|---|---|
| Hydrogen | 28·8 |
| Nitrogen | 28·8 |
| Carbon monoxide | 4·8 |
| Carbon dioxide | 2·6 |
| Oxygen | 2·7 |
| Marsh gas | 32·3 |
| | 100·00 |

The candle power of the gas is from 8 to 9, and will be referred to later on. It is unfortunate that, owing to the two batteries being inter-connected, it is impossible to make a trial of the relative production of the gas from the two types of ovens.

At the above plant, the excess gases are at present utilized in two ways—firstly, for firing steam-boilers; and, secondly, for lighting the colliery village and the adjacent streets. The method of utilizing the gas under the boilers is very simple. There is a brick combustion chamber, and the gas is burnt in a bunsen burner. Coupled with the waste heat from the ovens, the gases are capable of evaporating 3000 gallons of water per hour, or 2400 lbs. of water per ton of coal carbonized.

Some years ago a small gas plant with 11 retorts was put down at the colliery for lighting the village; and after the erection of the coking plant, it was suggested that any excess gas from the ovens should be utilized. The method of doing this was very simple. A T-pipe and valve were placed on the meter side of the hydraulic main at the gas-works, so that the coke-oven gas passes through the ordinary scrubbers and purifiers of the small gas-works, in addition to the scrubbing apparatus at the coking plant. Tar, ammonia, and benzol are recovered from the gas at the ovens; but the pipe supplying the gas-works takes away the gas from the ovens before the benzol scrubbers are reached. From the purifiers, the gas passes through a benzol enriching apparatus made by the Simon-Carvès Company. During the past two years, an average of 27,000 cubic feet of gas per day has been enriched from 8 or 9 candle power to 14 or 15 candle power, at a cost of 2·8d. per 1000 cubic feet; and a saving to the colliery of some 800 tons of small coal per annum has been effected.

The question of employing the gas in engines has been under consideration from time to time; but owing to the fact that a steam-engine plant is already in operation at the colliery, it was considered that to utilize the gas as indicated above was perhaps the best method to be adopted. Owing to the situation of the ovens, the driving of electric generators is the only method that could be applied to make use of such gas-engines; and the electrical requirements of the colliery are at present rather small. Another feature militates against the use of gas-engines at the plant; and that is the fact that the coal being washed and very small varies in its gas-producing capacity, and though it has been stated that there is an average of 1750 cubic feet of excess gas per ton it would necessitate the erection of large holders in order to counteract the variations in supply.

The writer has already stated that it is the general opinion that the vertical-flued oven gives more excess gas for lighting and other purposes than the horizontal-flued oven does; and he will therefore describe some of the results from a battery of vertical-flued ovens, also erected by the Simon-Carvès Company.

### Vertical-Flued Ovens.

These ovens are 40 in number, and are provided with regenerators, and at present produce 1000 tons of coke per week, or an average of 25 tons per oven, against 1391 tons

per week, or 21·38 tons per oven, in the plant as previously described. It is claimed that the vertical-flued ovens have no less than half the total gas produced to spare; but this has not yet been proved, because there are no means of measuring accurately. There is, however, a good deal more to spare than from the horizontal-flued ovens.

During the next twelve months, the writer hopes to have a battery of vertical-flued ovens working alongside a battery of those of the horizontal-flued type; and both plants will use exactly the same class of coal. He then intends to put measuring apparatus on both batteries, so as to obtain as accurate data as possible. The result of such measurements will be very interesting, as well as useful, because the horizontal-flued ovens now at work are quite modern—having been started only some eighteen months ago.

At the vertical-flued oven plant, the gas has the following analysis, taken over a period of eight weeks:—

| | Per Cent. |
|---|---|
| Carbonic oxide | 8·41 |
| Carbon dioxide | 4·29 |
| Marsh gas | 28·21 |
| Hydrogen | 39·85 |
| Oxygen | 0·46 |
| Nitrogen | 18·78 |
| | 100·00 |

During the early part of the coking process, the gas has a calorific value of about 450 B.Th.U.; but during the process of coking, it decreases in quality, and at the end its calorific value is only something like 350 B.Th.U.

It will be noted that the gas contains a good deal of hydrogen and other highly inflammable constituents, which make it somewhat difficult to utilize in large engines, owing to the liability of pre-ignition; but the two Körting two-cycle double-acting engines which are now in use have given every satisfaction since they were first installed, and have now been in successful operation for a period of over twelve months. They are designed to develop 400 I.H.P. with an over-load capacity of 600 I.H.P.; and they have already proved themselves capable of producing the over-load for as long a period as a week. Each engine is direct-coupled to a 225 K.W. continuous-current generator, at a pressure of 500 volts. As a rule, each engine works for 36 hours, and then stands for 12 hours; one engine taking the load during the lighter portion of the 24 hours, while both are running during the day. The current generated is used for various purposes—chiefly in the coal washery and at the iron-works with which the coke-ovens are connected.

The sole trouble that arises is owing to the tar in the gas, which it is almost impossible to entirely eliminate; so that it is necessary to take the valves down and thoroughly clean them out about once in every four weeks. The only note the writer has to make on the working of the engines is that, owing to liability to pre-ignition, it has been found necessary to reduce the compression from what was originally designed to about 80 lbs. per square inch.

After supplying gas for driving these engines, there is a considerable further quantity to spare which is utilized under the steam-boilers; but owing to the absence of measuring instruments, it has not been found possible to ascertain the value of such gas.

## THE CARBONIZATION OF COAL, WITH SPECIAL REFERENCE TO THE BYE-PRODUCT COKING PROCESS.

**By ERNEST BURY, M.Sc., F.C.S., of Little Hulton.**

When it was first suggested to the writer that he should submit a paper to the Institution, dealing with the adaptability of the bye-product oven to the manufacture of illuminating gas, he hesitated to accept the honour, for the reason that the plant of which he is manager is not at present equipped for the disposal of its gas in any other manner than for its use in the carbonization process—the surplus being used for steam-raising.

Being unable to submit an account of a coke-oven plant as a working gas-works reality, it seemed to him that he would be lacking in sufficient material to institute a perfect comparison between the bye-product coking process and present gas-retort methods. On arranging the results of a long series of observations of actual coke-oven practice, and comparing these with similar investigations with the gas-retort, he found, however, that there were many matters wherein a comparison between the two processes might be made, without actually commercial results being necessary. This being the case, he at length decided to submit the following facts for consideration.

*Notes on the Development of the Bye-Product Coking Industry in the United Kingdom.*—With the gradual extermination of the blast-furnace managers' prejudice against bye-product coke, the growth of the process in this country has made rapid strides. Many iron-smelting firms have themselves adopted bye-product plant for the manufacture of their own coke, and have thereby given the best possible denial to the supposition that bye-product coke was unsuitable for iron-smelting. In 1898, Mr. George Beilby estimated that 1,250,000 tons of coal were carbonized in bye-product ovens in the United Kingdom. On referring to the Board of Trade report for 1905, it will be found that the following bye-product ovens were at work in that year: Simon-Carvès, 726; Semet-Solvay, 470; Bauer, 52; Koppers, 72; Otto-Hilgenstock, 503—total, 1823. Other figures are to hand, of which the proportion of bye-product plants is not stated —*e.g.*, the Coppée installations. The above therefore is a minimum estimate for the number of plants at work. No statement is given in the report of the amount of coal taken by these ovens; but if an average of 5 tons per oven per twenty-four hours be allowed, a minimum estimate of 3,317,000 tons carbonized in that year by the bye-product process is arrived at, or an increase to 2½ times the amount estimated by Mr. Beilby seven years previously.

The same report gives the total amount of "coal employed in the manufacture of coke," including gas-works processes, bee-hive ovens, non-recovery ovens of various types, and bye-product retort ovens, at 33,453,000 tons. The number of bee-hive ovens is given at 25,514, and other non-recovery ovens at 2233. Allowing a consumption of 9 tons of coal per week for the former, and 5 tons per day for the latter, it is found that approximately 16 million tons are taken by types of oven not constructed to recover gas or bye-products. This quantity added to the 3·3 million tons carbonized in bye-product plants, gives a total quantity of 19·3 million tons of coal employed per annum for the manufacture of coke for iron-smelting. Mr. Beilby gave the quantity of coal carbonized for gas making in 1898 at 13 million tons. After subtracting from the above total the coal required by coking plants for 1905, the result is 14·18 million tons as the amount taken by gas-works in that year.

From these figures it will be seen that not only is the number of bye-product ovens increasing, but, in view of the fact that the greater bulk of the coke for iron-smelting purposes is still made by non-recovery processes (principally the bee-hive oven) there is enormous scope for development. The heavy waste of the bee-hive oven—comprising 10 per cent. loss in coke yield, the whole of the gas, tar, sulphate of ammonia, and benzol—is now a subject of almost common knowledge; and with the successful application of the bye-product process to British coals, a gradual replacement of the bee-hive oven by the more economical process must be looked for.

The estimate also indicates that the amount of coal already being treated in bye-product ovens is approximately 23 per cent, of that carbonized at the country's gas-works. If for the moment it can be accepted that the whole of the gas generated in bye-product coke-ovens could be applied for town's lighting, then at the present time we are carbonizing by the oven and retort processes 23 per cent. more coal than the country needs for the production of its light. Up to now, the application of the surplus gas made at bye-product plants has been alone considered. Taking this surplus at one-third of the quantity generated, it will be seen that an excess of 7·6 per cent. of coal is being carbonized above requirements. It is not, of course, practical to consider (admitting the coke-oven gas to be applicable) that a general saving to the country's coal supplies could be effected as indicated above, since the districts where bye-product coke manufacture is carried out at present are far removed from the bulk of the towns where it is required. But the figures are so striking that they call for an inquiry into the value of bye-product plants as a source of lighting supply, to ascertain whether, from future installations and in certain present cases, a portion or the whole of the coke-oven gas generated could not be applied as a saving to the community.

*The Utilization of the Surplus Gas from Bye-Product Ovens.*—With one or two exceptions, little attempt has been made in this country to apply the surplus gas made by the process to the lighting of townships. In some cases, the gas is

successfully employed in gas-engines for the generation of electricity; but by far the greater bulk is consumed under boilers for raising steam. Assuming for the moment that coke-oven gas approximates in composition to that from gas-works, little economy attaches to burning it, after paying all carbonizing charges, for a purpose where coal would equally suit. The gross calorific equivalent of 100,000 cubic feet of coke-oven gas (at 540 B.Th.U. per cubic foot) —would be 54 million B.Th.U., and that of 1 ton of coal (14,000 B.Th.U. per lb.) 31·36 millions—that is to say, the gross calorific equivalent of 100,000 cubic feet of oven gas would be met by 1·72 tons of coal. Attributing even a low market value to the gas, it will be seen that it is worth far more than the boiler coal which could take its place.

Our American friends have not been slow to realize the value of the surplus gas at their coking plants; and several large towns in the States are now being lighted from this source of supply. Dr. Schniewind gave at the Glasgow Engineering Congress in 1901 the results of the Otto installation at Everett, Mass.; and since that time other American observers have published their experience. At Everett, Dr. Schniewind stated that 10,390 cubic feet of gas are obtained per ton from Dominion coal, of which 5143 cubic feet of 14·7-candle gas are available surplus for lighting the town, after suitable enrichment. At a meeting of the New York Section of the Society of Chemical Industry, on March 24, 1905, Mr. Atwater quoted Dr. Schniewind's work, and gave it as his opinion, that, for all classes of coal, an average of 3500 cubic feet of surplus gas could be obtained per ton. At the same meeting, Mr. Pennock gave the surplus gas per ton from the Semet-Solvay ovens at Milwaukee and Detroit at 3400 and 3100 cubic feet respectively; the total quantity of surplus coke-oven gas consumed at these towns per day being 2,700,000 and 1,900,000 cubic feet.

The author has had no means of accurately gauging the surplus gas per ton at the Bridgewater Collieries; but from practical manipulation of the plant, he can safely approximate the amount at one-third of the quantity generated. He has, for instance, without effort employed the surplus gas from 25 ovens to heat 13 additional ovens. From other considerations, to be mentioned later, he judges the total yield to be 9000 cubic feet per ton; and he, therefore, considers that, from the class of coal generally employed for bye-product coking, 3000 cubic feet of surplus gas per ton of coal may be expected, as stated by Messrs. Atwater and Pennock.

Both Dr. Schniewind and Mr. Pennock give curves representing the calorific and illuminating power of the gas evolved at different stages of the coking operation for Otto and Semet-Solvay ovens. The writer has seen no record of tests for British coals executed upon the same lines. He has therefore repeated their experiments—employing the Semet-Solvay oven with Lancashire slack. The time of carbonization in the three cases given on Diagram 1 is

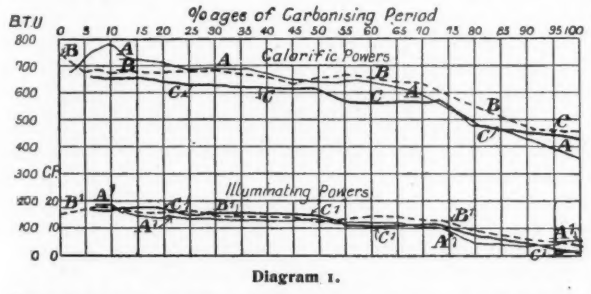



**Diagram 1.**

Comparison of the calorific values and illuminating powers of coke-oven gas from American and British coal at percentage intervals of the total carbonizing period.

Curves A, A¹: Otto-Hoffmann Oven, Dominion Iron and Steel Company (Mass., U.S.A.); carbonizing time, 34 hours.
,, B, B¹: Semet-Solvay Oven, Chester Gas Company (Chester, Pa., U.S.A.); carbonizing time, 20 hours.
,, C, C¹: Semet-Solvay Oven, Lord Ellesmere's Bridgewater Collieries, Lancs.; carbonizing time, 17 hours.

different, owing to the varying widths of the charge of coal employed and the different percentages of moisture and volatile matter in the coal itself. In order to effect a comparison, he has in each case, therefore, put the total carbonizing time at 100, expressing the intervals when the tests were made as percentages of the total period. The table gives particulars of the dimensions of the three ovens employed, time of carbonization, &c.

From these results it will be seen that remarkable similarity exists in the values of the gas obtained by the three sets of experiments, when it is remembered that different coal was employed in each case. It would also appear that the changes in the values of the gas as the carbonization proceeds are dependant upon the percentage of time which has elapsed from the commencement of carbonization; the chief downward break in the curves taking place at approximately the same period of time in each case. It likewise seems clear that with differences in the height and width of the charge, there is little to choose in the quality of the gases obtained. This is particularly interesting in view of the fact that the weight of coal carbonized per unit of time in the three cases was as follows: (1) Otto-Hoffmann = 4·7 cwt. per hour; (2) Semet-Solvay (Chester) = 8 cwt. per hour; (3) Semet-Solvay (Bridgewater Collieries) = 4·7 cwt. per hour. The advantage in the amount of coal carbonized per unit of time in the No. 2 was due to a much greater depth of the charge. The output of Nos. 1 and 3 could have been similarly raised by increasing the working depth of the oven from 5 ft. 9 in. to 8 ft.

All the tests on the diagram were made without removal of the carbonic acid; the tests at Bridgewater Collieries being made upon an oven in the working batteries, in order to obtain results as near as possible to those which would obtain in practice. The illuminating power tests were observed at a 5 cubic feet rate; the standard sperm candle and No. 1 "London" argand being employed. The calorific values were taken with a Simmance-Abady calorimeter, using small quantities of water in the determinations. The analyses of the whole of the gas generated at the three places are shown in the following table:—

| — | Otto-Hoffmann Ovens, Everett. | Semet-Solvay Ovens, Chester, Pa. | Semet-Solvay Ovens (Bridgewater Collieries). |
|---|---|---|---|
| | Per Cent. | Per Cent. | Per Cent. |
| $CO_2$ . . . . | 2·9 | 1·8 | 2·5 |
| $O_2$ . . . . | 0·3 | 0·5 | 0·4 |
| $C_2H_4C_6H_6$ . . | 3·8 | 3·2 | 3·7 |
| CO . . . . | 6·2 | 4·6 | 6·4 |
| $CH_4$ . . . . | 33·9 | 36·5 | 33·9 |
| $H_2$ . . . . | 44·4 | 43·8 | 49·1 |
| $N_2$ . . . . | 8·5 | 9·6 | 4·0 |

It is evident therefore that the method of dealing with the surplus gas employed in America—viz., the application of the rich gas evolved during the earlier stages of the process to the lighting of townships—could likewise be followed in this country, in cases where coke-oven plants producing blast-furnace coke are adjacent to large cities. The carbonizing capacity of bye-product coking plants generally ranges from 100 to 400 tons per day. Given 3000 cubic feet per ton as surplus, such plants could supply from 300,000 to 1,200,000 feet per day, equal to the requirements of towns of from 3000 to 12,000 consumers. The average illuminating value of the "rich" surplus gas as made is 14 to 15 candles; so that, using the incandescent mantle, no enrichment is required.

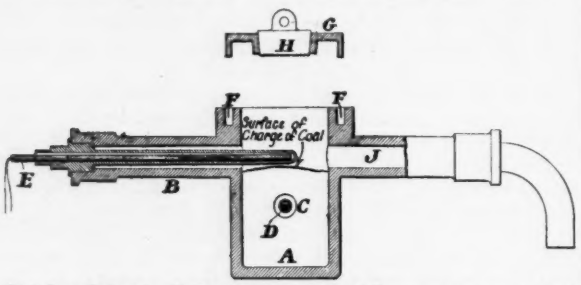
*Possibilities of Employing the Whole of the Gas Generated from the Bye-Product Process for Town's Lighting.*—The employment for lighting purposes of the whole of the gas evolved from the bye-product coking process, using some other means for heating the ovens than a portion of the gas itself, is a question which has been little discussed.

Briefly the points at issue are:

1.—Can the bye-product oven compare with the gas-retort in the volume and quality of the gas produced?

| Location. | Owner. | Type of Oven. | Height. | Length. | Width. | Volatile Matters. | Moisture in Slack Charged. | Time of Carbonization. Hours. |
|---|---|---|---|---|---|---|---|---|
| | | | Ft. In. | Ft. | In. | Per Cent. | Per Cent. | |
| Everett, Mass. . . | Dominion Iron and Steel Co. | Otto-Hoffmann | 5 10 | 33½ | 20¾ | 34·6 | 9·9 | 34 |
| Chester, Pa. . . . | Chester Gas Co. | Semet-Solvay | 8 0 | 30 | 17 | Not given | | 20 |
| Bridgewater Collieries, Lancashire. . | Lord Ellesmere | Semet-Solvay | 5 9 | 30 | 16 | 30·2 | 7·1 | 17 |

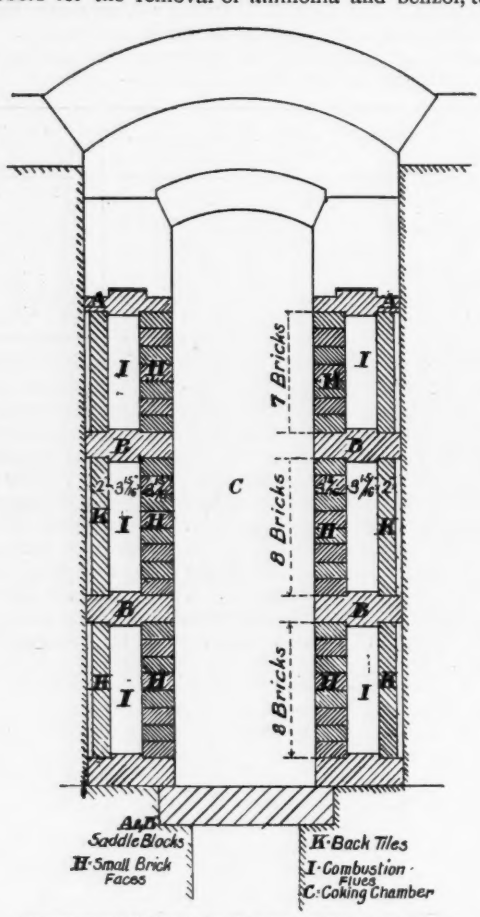
2.—What are the commercial advantages to be gained by carbonizing coal in bulk, and would these more than compensate for any inferiority the bye-product coke-oven might show as a gas-making apparatus?




**Cast-Iron Retort for Estimating the Effect of Temperature on the Yield and Composition of Gas.**

A, Body of retort. B and C, Pipes cast with body of retort to carry thermo-junctions. D and E, Thermo-junctions. F, Luting filled with moist fire-clay into which the lid G is pressed. H, Plug (removable) for charging purposes. J, Gas outlet.

In order to discuss these points, a brief general description of the bye-product process is necessary. The carbonizing operation consists in charging a large bulk (from 4 to 8 tons) of disintegrated washed coal into a chamber measuring from 30 ft. to 33 ft. in length, 5 ft. 9 in. to 8 ft. in height, and 16 in. to 21 in. in width; the side walls forming the chamber carrying flues in which a portion of the gas previously evolved is burned with admixture of preheated air. The gas distilled from the coal passes from the chamber, through an ascension pipe, into a hydraulic main, whence it is drawn, through air condensers and a tar-washer, into the exhauster, which returns the gas, through suitable scrubbers for the removal of ammonia and benzol, to the




**Arrangement of Bricks in the Semet-Solvay Coke-Oven.**

heating flues of the ovens. Sketch No. 1 shows a section through the coking chamber and flues of a Semet-Solvay oven. The surplus gas not required for the flues is burned under the steam boilers; the hot waste gases from the flues being made use of in like manner.

The oven-chamber is constructed of the best fire-clay blocks or small bricks; the general tendency now being in favour of the latter as facilitating repairs. The chamber is closed at the ends by large cast-iron doors, at the top end of which is a small door, 10 inches square, for introducing the levelling rakes. These large doors are sometimes hinged to iron frames set against the ends of the ovens, but preferably allowed to lean against a fire-brick batter. Charging holes are provided in the crown of the oven, through which the coal is run into the chamber from iron hoppers, which carry the charge from the storage bunkers.

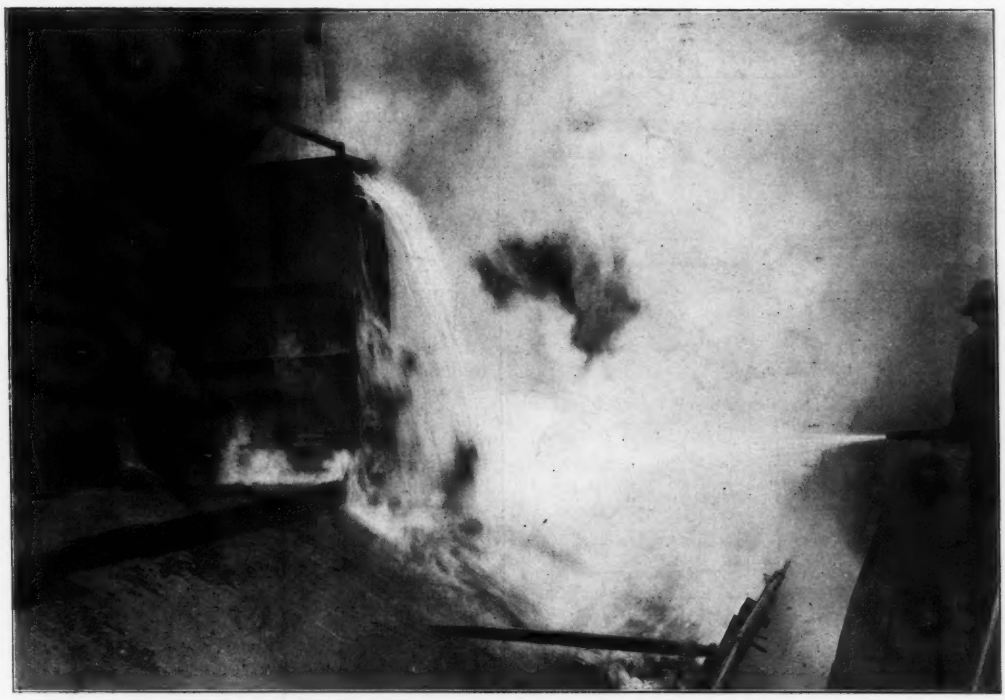
The charge of coke is discharged from the oven by a steam or electric ram into a steel car, where it is quenched. The car travels on a railroad in front of the ovens, along which it is drawn by a steam or electric winch to the screening shoot, which delivers the different sizes of coke into their respective waggons. Photograph No. 1 illustrates the discharging of a batch of coke weighing 2 tons 16 cwt. through a slacking hood into the coke-car. Photograph No. 2 shows the car discharging its load over the screen into the railway waggons. The operation of discharging, quenching, and loading a charge of coke into a customer's waggons occupies 20 minutes.

Immediately after the charge of coke has been rammed, the large doors are plastered, after which the coal is run into the oven from the hoppers, and either levelled by hand-rakes or a levelling machine; the latter consisting of a bar with a rack on its underside, and propelled by a pinion. When the charge of coal has been introduced, the levelling doors and the charging-hole lids are put on, and luted whenever necessary. When levelling by hand, the whole operation of discharging and recharging occupies about 15 minutes, and with the levelling machine 8 minutes. The time occupied in carbonization varies from 17 to 34 hours, according to the width of the charge and the percentage of moisture in the washed coal. The constitutional differences between various types of oven are confined almost entirely to the side wall heating arrangements, and methods for preheating the air necessary for the combustion of the gas in the heating flues. Of necessity, the condensing, scrubbing, and exhausting apparatus is similar to, or consists in modifications of, types used by gas engineers all the world over. A valve is, however, necessary for shutting off the oven from the hydraulic main during discharging and charging, since the time occupied by these operations is much longer than in the case of a gas-retort, which gives a greater opportunity for air to be drawn into the gas by the exhauster.

*Comparison of the Above Conditions of Carbonizing in the Bye-Product Oven with those in the Gas-Retort.*—The essential differences between the two processes of bye-product coke-oven and retort carbonization are: In the gas-retort a charge of 6 cwt. of coal is employed, varying in depth from 6 inches to 12 inches. The coal is dry, and varies in size from a fine powder to pieces of nut or cobble size. In the coke-oven, a charge of 4 to 8 tons of moist, crushed coal is carbonized, measuring 17 inches to 34 inches in width, and from 5 ft. 9 in. to 8 ft. in depth. The results of these differences may be summed up in favour of the gas-retort, since with a lighter charge of a more open character, the heat from the flues rapidly penetrates to the centre of the mass, resulting in a more rapid evolution of gas, which hurries out of the retort, presenting a minimum opportunity for the hydrocarbon breakdown.

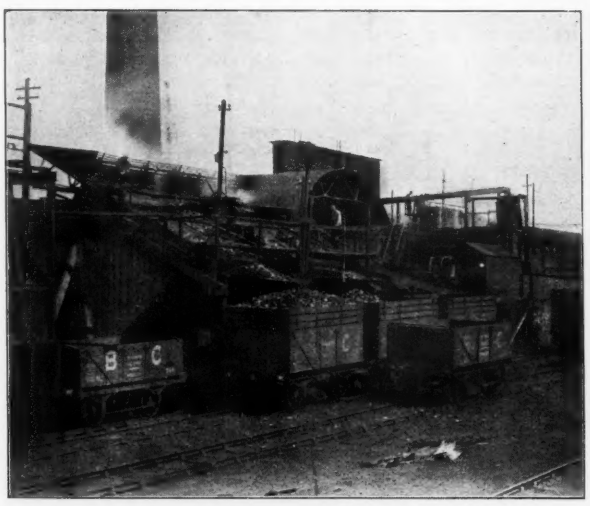
In his paper, on "Pyrometers and Carbonization," read before the Institution in May, 1905, the writer's friend, Mr. J. Bond, of Southport, gave curves representing the temperatures at different parts of the retort throughout the carbonization, employing Lancashire coal of bean size. These curves were obtained by a Roberts-Austen pyrometer with recorder, employing thermocouples of platinum and platinum-rhodium. In his diagrams Nos. 11, 13, and 15, Mr. Bond gave the temperature at the centre of the charge, curve F in each case. These curves were obtained by employing different layers of coal in the retort, with varying heats. In Diagram No. 2 these curves are plotted alongside a record of temperature at the centre of a coke-oven charge throughout carbonization, likewise obtained by a Roberts-Austen pyrometer with similar couples.

Diagram No. 3 shows that extensive distillation does not take place from coal until a temperature of 500° C. is reached; and in order that the author might be able to form a comparison between the two processes, as regards the "rate of heat penetration," he has taken 500° C. as a standard temperature.



**Photograph No. 1.—Discharging Batch of Coke through Slacking Hood into Coke Car.**

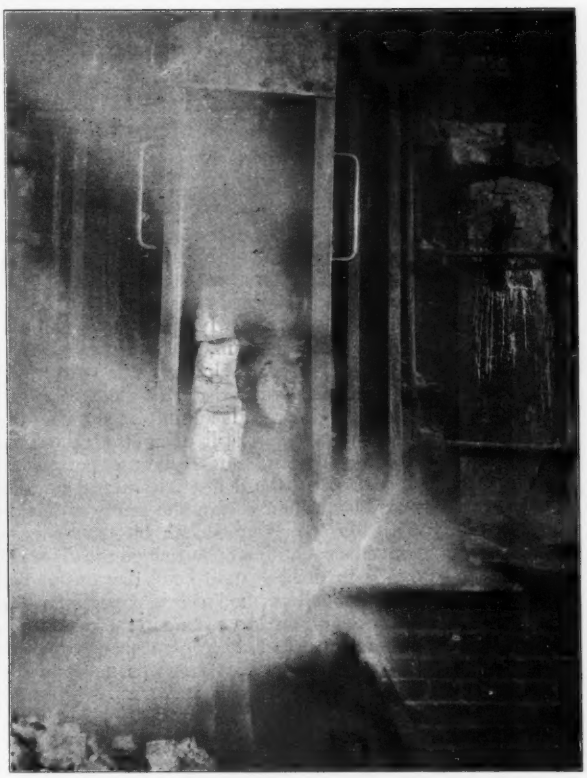
In the gas-retort, the heat penetrates to the centre of the coal from the bottom and crown of the retort, a horizontal fracture taking place where the two planes of heat coincide. In the coke-oven, the heating planes advance to the centre from the side-wall flues, forming a vertical fracture, as seen from the Photograph No. 3. The thickness of the layer of coal penetrated in a given time was, therefore, measured from the top



**Photograph No. 2.—Coke Car Discharging Batch of Coke over Screen into Railway Waggons.**

to the centre of the charge in the gas-retort, and from the side to the centre of the charge in the case of the coke-oven. The particulars furnished by the records of temperature in the centre of the gas-retort and coke-oven charges give the figures for the next table:—

| — | | Flue Temperature. | Total Depth of Charge. | Distance to Centre of Charge. | Time Occupied in Attaining a Temperature of 500° C. at Centre. Hours. | Heat Penetration in Inches per hour. |
|---|---|---|---|---|---|---|
| Gas-Retort | Curve A . | High { 1125° C. to 1160° C. | 6 in. | 3 in. | 0·25 | 12 in. |
| | Curve B . | Low | 6 in. | 3 in. | 3·0 | 1 in. |
| | Curve C . | High | 12 in. | 6 in. | 5·8 | 1·03 in. |
| Coke-Oven | Curve D | High { average 1150° C. | 16 ins. (width) | 8 in. | 12·5 | 0·64 in. |



**Photograph No. 3.—Vertical Fracture of Coke at Centre of Charge Resulting from Radiation of Heat to Centre.**

The rate of carbonization was given for the gas-retort at 12·8 tons per 1000 square feet of retort surface in 6 hours. The rate of carbonization for a coke-oven, measuring 30 ft. by 5 ft. 9 in. by 16 in., carbonizing 4 tons in 17 hours, works out at 9·41 tons in 17 hours; the rate of carbonization per 1000 square feet per hour in the two cases being: Gas-retort, 2·13 tons; coke-oven, 0·55 ton.

It will be seen therefore that coal is distilled much more slowly in the case of the coke-oven; and apart entirely from the question of the amount of coal carbonized per unit of time, the effect of slow distillation upon the yield and quality of the gas evolved has to be considered. To take an extreme case, if a quantity of coal be heated slowly from the cold, its yield will be only one-third of the quantity which

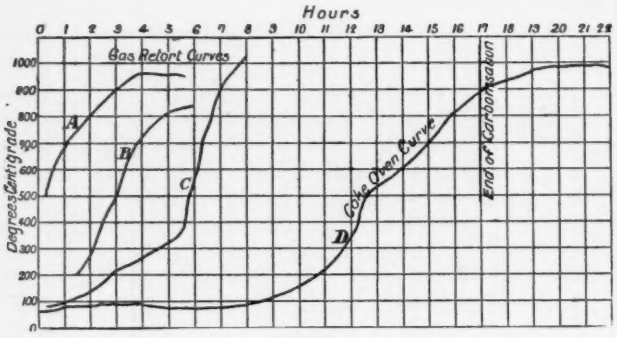



**Diagram 2.**

Curves of temperature throughout carbonization in centre of gas-retort and coke-oven charges.

Curve A: Gas-retort charge, 6 inches thick; high heats.
" B: " " " 6 " " low "
" C: " " " 12 " " high "
" D: Coke-oven " 16 " wide; " "

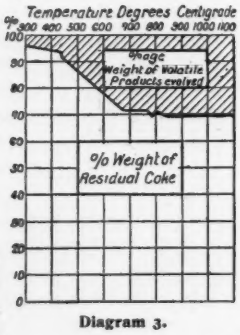



**Diagram 3.**

Percentage weight of volatile products evolved at different temperatures.

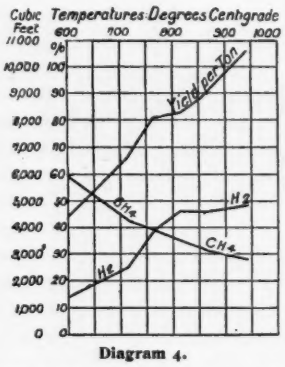



**Diagram 4.**

Effect of temperature upon the yield per ton and upon the percentage volume in the gas of the two chief constituents, $H_2$ and $CH_4$.

would be obtained if it were charged at 950° C. What, therefore, will be the effect on the yield in a coke-oven where heating of the charge proceeds very gradually? As the two planes of heat advance slowly to the centre of the charge, as indicated by the diagram, there must be intermediate zones of temperature, far below the temperature of the oven walls. That temperature equals yield is a gas engineer's maxim; but a diagram is submitted showing the effect of temperature upon yield, still using the same coal employed in the foregoing and subsequent experiments. Before proceeding to explain these tests, it must be added that the coal employed was slack—*i.e.*, the inferior portion of the seam. With burgy or round coal, bigger yields of better gas would have been obtained; but since the object of bye-product coking is to utilize small coal, the author has carried out all experiments described in this paper upon the same coal, which is coked on the large scale in the ovens.

In order to ascertain the effect of temperature upon yield, for the particulars on Diagram No. 4 it was necessary to take small quantities of coal, to avoid as far as possible the evolution of gas at intermediate temperatures. 1 lb. of coal was therefore employed. The retort was made of cast iron, and provided with branch pipes for carrying the couples, of which two were employed (*a*) with the thermo-junction at the centre of the charge of coal; (*b*) with the thermo-junction at the top of the retort immediately above the coal. The retort was built in a fire-brick setting to prevent radiation, and was heated by a large burner supplied with blast from a Roots' blower. The retort was connected with a Liebig's condenser and a series of wash-bottles, the inlet pipes of which were covered with wire-gauze to frictionally remove tar-vapour. Thence the gas passed into the holder, which had been accurately calibrated against a reliable meter. The regulation of any required temperature within the retort was found to be a comparatively simple matter. The coal under experiment was weighed into an iron pipe, on inserting the end of which through the charge-hole of the lid the coal could be run into the retort without loss. After charging, the pipe was removed; a plug quickly inserted; and the evolved gas switched on to the holder. The gas was allowed to leave the retort at a pressure of ½-inch of water—the end of the carbonization being determined when the retort ceased to throw a pressure; also by the equalization of temperature at the centre of the charge with that at the top of the retort.

From Diagram No. 4 it will be seen that the yield of gas is mainly proportional to the formation of $CH_4$ and $H_2$—the two chief constituents—by volume. With a low temperature, a low yield of gas, a low percentage of $H_2$, and a high percentage of $CH_4$ are obtained. With a high temperature, a high yield, with a high percentage of $H_2$, and a low percentage of $CH_4$ are the result. So regular is the interchange between the $CH_4$ and $H_2$ with increasing temperature of generation (the curves for the percentages of these gases being almost reciprocals) that for any one coal which has been tested at various temperatures, it is possible to gauge the average temperature at which it was carbonized, by reference to the percentage of $CH_4$ in the gas obtained—*e.g.*, our oven gas from the same coal contains 34 per cent. of $CH_4$, which would correspond to an average generation temperature on the diagram of 800° to 810° C., though the coal would be charged into the ovens with a temperature of 900° C. The yield of gas at 800° to 810° C. would be 8300 cubic feet per ton as the primary yield, independent of any addition of hydrogen by breakdown of heavy hydrocarbons, of which I will speak shortly.

Taking the conditions of the small experimental retort to be approximately similar to those of the working gas-retort, in that it affords an opportunity for rapidly heating the coal, we find, on referring to the curve, that at an initial temperature of 900° C., the yield of gas per ton would be nearly 10,000 cubic feet. Having obtained confirmatory results by checking this method of determining the effect of temperature upon the character of the gases, the author is prepared to state that in the coke-oven the coal gives off its gas at a lower average temperature than is the case in the gas-retort—the coal being charged in both instances at the same initial temperature. This being the case, it follows that the yield per ton from the retort will be higher than that from the coke-oven at the moment of generation.

Diagram No. 5 shows the percentages of heavy hydrocarbons contained in the gas from the same coal charged into the retort at various temperatures. A line is also shown on the diagram representing the average percentage of illuminants in coke-oven gas.

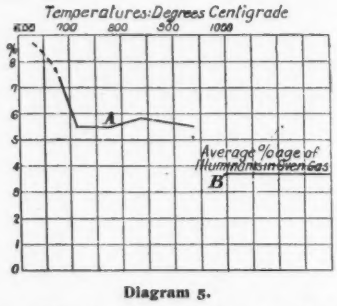



**Diagram 5.**

Percentage of illuminants (heavy hydrocarbons) in gas from coal heated at various temperatures (A) compared with the average percentage in coke-oven gas obtained from the same coal (B).

It will be seen that at no temperature does the percentage of illuminants drop to the low figure contained in oven gas; and the obvious conclusion is that in the oven these bodies have been primarily generated, but have been subsequently broken up during the slow passage of the gas over the large amount of hot surface. This breakdown adds a little to the bulk of the gas, but at a large expense of heating and lighting efficiency. Comparing the lowest percentage of illuminants found in the small-scale experiments (5·4 per cent.) with the average for coke-oven gas (3·7 per cent.), it is found that 31·5 per cent. of their original amount has been destroyed by the carbonization in bulk. Comparing again the experimental retort employed with the working gas-retort, it is found that, even at a temperature of 940° C., 5·4 per cent. of illuminants were present in the gas collected, but in this case the gas hurried out of the retort before being broken up.

Diagram No. 6 shows the calorific value compared with the yield obtained by the small-scale experiments, together with the average calorific value of oven gas.

From these figures it will be seen that the largest yield of true gas of which the coal is capable at about the highest

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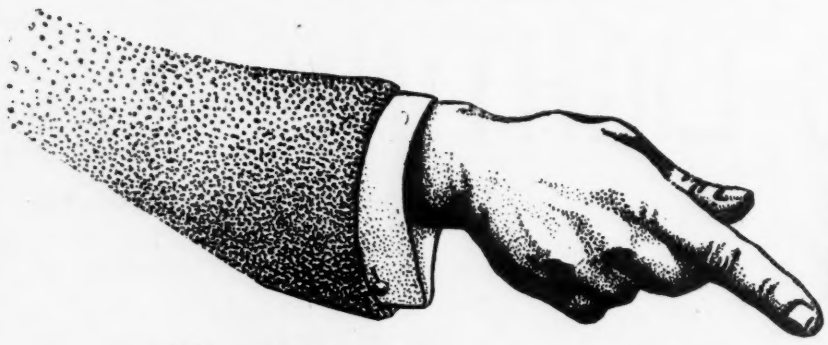

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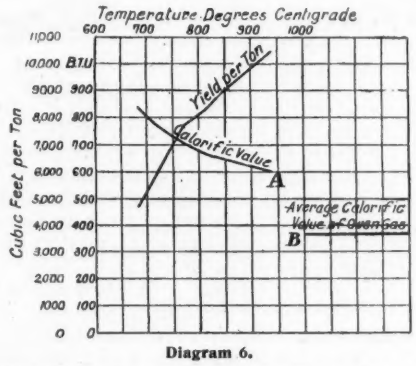


**Diagram 6.**

Calorific value of gas from coal charged at various temperatures compared with the yields obtained at similar temperatures. Line B shows the average calorific value of oven gas obtained from the same coal.

working temperature—viz., 940° C.—is 10,483 cubic feet per ton, having a calorific value of 600 B.Th.U. The average calorific value of the oven gas is 546 B.Th.U., with a $CH_4$ percentage corresponding to a generation temperature of 800° to 810° C., at which the coal would give a gas yield of 8300 cubic feet of 665 B.Th.U. Allowing for the decomposition of 31·5 per cent. of illuminants as shown, the largest yield of oven gas which could be expected from the coal under test would be approximately 9000 cubic feet per ton of 550 B.Th.U.

From these experiments, therefore, the author concludes—

1.—That in the coke-oven the coal is heated at a lower temperature than it is in the gas-retort, and that the yield is therefore primarily lower; that any further addition to the yield takes place at the expense of the illuminants; but that, even after this has occurred, the total yield is 10 per cent. lower than would be obtained from the gas-retort using the same coal.

2.—That in the gas-retort the heat penetrates rapidly to the centre of the charge, with the result that the gas is generated at a higher temperature, leading to a bigger primary yield; furthermore that, owing to the minimum heating surface which is presented to the evolved gases, the illuminants escape from the retort before decomposition has time to take place, thereby maintaining a high yield with a greater heating and lighting efficiency.

It is evident, therefore, that as a gas-making apparatus the retort is superior to the coke oven.

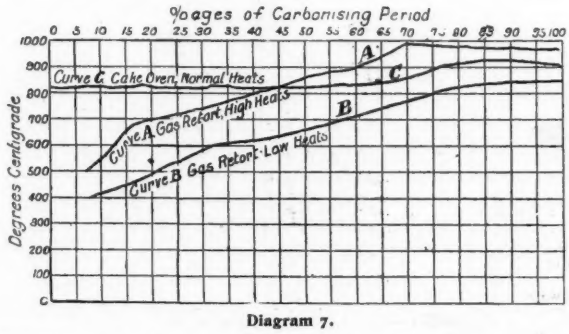


**Diagram 7.**

Temperature at the crown of the gas-retort and coke-oven at percentage intervals during carbonization.

Curve A: Gas-retort; high heats.
,, B: ,, ,, low ,,
,, C: Coke-oven; normal heats.

Before leaving the subject of the temperature influences which operate in the coke-oven and retort, references may be made to Diagram No. 7, showing the temperature of the gases immediately above the layer of coal. On this diagram are plotted the highest and lowest records of temperature which Mr. Bond obtained in the gas-retort at this point at percentage intervals of the carbonizing period, together with a normal record which the writer has obtained in the oven.

It will be seen that with the highest heats which Mr. Bond employed the temperature at the top of the charge in the gas-retort did not come up to the temperature at the crown of the oven until 40 per cent. of the carbonizing period had elapsed. The decomposition of the gases which takes place with the slowly-distilled charge in the coke-oven, coupled with the large heating surface, is therefore still more readily understood.

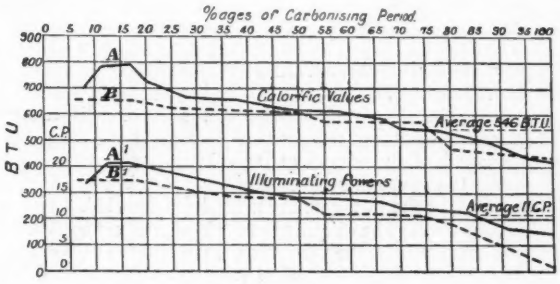


**Diagram 8.**

Comparison of calorific values and illuminating powers of retort and coke-oven gases at percentage intervals of the total period of carbonization.
Curves A, $A^1$: Gas-retort. Curves B, $B^1$: Coke-oven.

To make a final comparison between the coke-oven and the gas-retort, calorific values and illuminating power tests of coke-oven gas have been plotted (Diagram No. 8) alongside the results which Mr. Bond obtained for a gas-retort, giving 10,137 cubic feet per ton of 14·25-candle gas. The comparison is as near as could be made without actually employing the same coal, since both sets of experiments were made with Lancashire slack. Lines indicating the average calorific and illuminating powers of coke-oven gas have likewise been inserted on the chart. The figures were obtained by employing a 3-inch gas-flame and correcting to a 5 cubic foot rate with a No. 1 "London" argand burner against a Harcourt 10-candle pentane lamp. The Simmance-Abady calorimeter was used to determine the heat values. The author considers that this last set of results fairly expresses the relative values of gas-retort and bye-product oven gas with yields of 10,137 and 9000 cubic feet respectively.

*Practical Aspect of Gas Making in the Bye-Product Coke Oven.*—Apart entirely from the chemical aspect of gas making in the bye-product oven and the gas-retort, there are some other matters in favour of the latter as a gas-making apparatus:—

1.—The bye-product coking chamber presents far greater opportunity for leakage of gas through the joints of the small bricks of which the oven is built than is the case with the jointless whole-piece gas-retort. From practical experience the writer knows this leakage to be considerable; and steps would have to be taken to reduce the opportunity for gas escape by employing dove-tail or wedge-shaped joints in the brickwork, before the bye-product oven could be made into a satisfactory retort.

2.—The large doors closing the ends of the chamber necessitate a big luted joint, which presents another facility for either leakage or indraught of air—in the one case resulting in loss of gas, in the other a lowering of illuminating and calorific efficiency by dilution with nitrogen. In some cases the doors are hinged to iron frames set vertically against the ends of the ovens. The author has found these frames work loose after a time, leaving a space for the gas to escape into the ends of the flues, through the passages admitting the heating gas. In all coke-ovens as little ironwork as possible should be used in closing up the ends of the chambers, since the employment of iron castings not only increases the wear and tear, but involves making an unnecessary joint between the iron and the brickwork. Preferably the ends of the ovens would be finished off with a fire-brick batter, against which the iron door, made with a big overlap, would lean with its whole weight—being kept in position by plain H girders, which would likewise act as slides when raising the door for discharging purposes. By adopting these means, this particular weakness of many existing coke-ovens would be improved from a gas-making point of view.

3.—The large doors present another drawback from the gas manager's standpoint, since the coal immediately against them escapes carbonization. This not only means a loss in gas yield per charge, but the production of a quantity of half-carbonized coke, known as "black-ends." It is these "black-ends" which have been responsible in a large measure for the prejudice against bye-product coke; and it is essential to separate them, in order to retain the blast-furnace manager's favour.

Mr. Beech, of the Snydale Collieries, has lately patented a flued coke-oven door, which is entirely successful in completely carbonizing the ends of coke-oven charges, so that this drawback, which is common to all classes of bye-product ovens, resulting in the production of 1 to 2 per cent. of uncarbonized coke, may be considered as surmountable.

4.—The coke-oven manager has to provide a hard coke for smelting purposes, which must be absolutely deprived of the whole of its volatile constituents. In order to ensure this characteristic, there is a tendency to keep the coke in the oven for too long a period. Dense, hard coke may be obtained in the bye-product oven without prolonging the operation to an abnormal extent. The limit of carbonization may be accurately determined by the pyrometer, and when the centre of the charge reaches a temperature of 900° C., it may be safely taken for granted that the whole of the volatile matter has been evolved. The limit of time thus taken for a single oven may then be applied as the required period for the same coal all through the plant. The author has seen cases where the carbonizing time—set down at 22 hours—became reduced to 17 hours by close pyrometric observations of the temperature conditions operating in the coking chamber, resulting not only in an increase of output, but in keeping the gas free from unnecessary dilution with nitrogen. If charges of coke are left "stewing" in the oven, under a wrong impression that the time must be prolonged to drive off the last traces of volatile matter, air is inevitably drawn into the oven, setting up a "producing" action. The gas is thereby weakened by nitrogen, and an abnormally high temperature set up for the reception of the next charge, which leads to unnecessary decomposition of the illuminants.

The following analyses indicate the best and worst of oven gas from the same coal; the quality of the coke being excellent in both cases:—

| 17 Hours Carbonization. Per Cent. | | | 22 Hours Carbonization. Per Cent. | | |
|---|---|---|---|---|---|
| $CO_2$ | 2·5 | | $CO_2$ | 2·0 | |
| $O_2$ | 0·4 | | $O_2$ | 1·4 | |
| $C_2H_4$/c. | 3·7 | | $C_2H_4$/c. | 2·1 | |
| CO | 6·4 | 540 B.Th.U. | CO | 7·0 | 480 B.Th.U. |
| $CH_4$ | 33·9 | | $CH_4$ | 24·8 | |
| $H_2$ | 49·1 | | $H_2$ | 51·8 | |
| $N_2$ | 4·0 | | $N_2$ | 10·9 | |

It will be seen, therefore, that on many counts carbonization in bulk in the bye-product oven at its best cannot compare in yield and value of gas with carbonization in small retorts, and, indeed, that the results obtained can be even worse unless the process is scientifically and practically handled.

*Economies of Carbonization in Bulk.*—The foregoing account of the coke-oven as a gas-making apparatus would at first sight appear to finally condemn the process as a source of illuminating gas supply. Further consideration, however, will show that, although the carbonization in bulk can never compare with the results of the small retort, under certain conditions the supply of a very cheap gas from coke-ovens could be made an accomplished fact. The bye-product process was designed for the manufacture of a good metallurgical coke from small or inferior coal at the pit-head. The coke made in the gas-retort, although it has been used in isolated instances, is not sufficiently strong for the requirements of modern blast-furnaces. That it has not found favour is proved by the increase in the number of bye-product coking plants of recent years, when plenty of gas coke was available. It may be taken, therefore, that the bye-product coking plant will continue to be required, and that gas from this source will go on increasing in quantity, irrespective of the supplies available from gas-works. Already, bye-product coking plants are taking over 20 per cent. of the amount of coal carbonized by gas-works. On a point of the economy of the country's fuel supplies, is it right that the two processes should overlap?

In order to effect any utilization of coke-oven gas for illuminating purposes, it would be necessary, in the first instance, owing to its inferiority to retort gas, to apply new standards of either lighting or heating efficiency. In the recent report of the "Royal Commission on Coal Supplies," it was stated that, with a general use of the incandescent mantle, illuminating power in gas would be unnecessary. It was further stated that large quantities of 8 or 9 candle gas were required to give economical incandescent lighting. Herein we have an indication that gas of 11-candle power and 550 B.Th.U. might shortly become acceptable. Making this assumption, consideration of the costs of manufacture of such gas can be proceeded with.

The coal employed in bye-product coking is of the very cheapest variety, known as slack. It ranges in size from dust to pieces about 1 inch square, and as it is raised from the pit it contains from 5 to 10 per cent. of foreign mineral matter, which has to be removed by washing, in order that the resulting coke may be clean. After washing, the coal is disintegrated to render the coke of dense character. The following estimate of cost is not taken from the books of any private firm, but is based upon a practical knowledge of the conditions under which bye-product coking could be most economically carried out, at a plant about to start work with already gained experience to hand—*i.e.*, wage conditions, execution of repairs, and manipulation all being known. The estimate is for a plant of fifty ovens, each capable of coking 8 tons per 20 hours, or a total capacity of 480 tons per day—*i.e.*, approximately the slack output of a large colliery. Given a yield of 9000 cubic feet per ton (calorific value = 540 B.Th.U.), the total yield would be 4,320,000 cubic feet per day, equal to the requirements of a big town.

The first cost of such a plant would be from £80,000 to £90,000. This sum would cover the cost of the ovens, condensing and scrubbing plant, washing and disintegrating machinery, storage bunkers, discharging and charging machinery, coke-removing plant, exhausters, boilers, and power generating machinery, sulphate plant, tar and liquor stores, and preparation of site and sidings. To complete the installation as a gas plant, there would require to be added for holders, purifiers, meters, governors, and mains (to the holder), a further sum of £92,000—that is to say, an approximate total first cost for the make and delivery into the holder of £182,000.

The labour required to handle the coal from the storage hoppers into the ovens, and the coke from the ovens into the railway trucks, employing electric haulage to draw the coal hoppers, levelling and ramming machinery, and coke haulage, would be as follows:—

| | s. | d. | | |
|---|---|---|---|---|
| 1 Ram driver | 6 | 0 | per shift of 8 hours. | |
| 2 Gas regulators at 5s. 6d. | 11 | 0 | ,, | |
| 1 Plasterer | 4 | 6 | ,, | |
| 1 Hydraulic main man | 5 | 6 | ,, | |
| 2 Chargers at 5s. | 10 | 0 | ,, | |
| 2 Slackers at 5s. | 10 | 0 | ,, | |
| 1 Haulage man at 5s. | 5 | 0 | ,, | |
| 1 Screen and car man | 4 | 6 | ,, | |
| 4 Stokers on producers at 5s. 0d. | 20 | 0 | ,, | |
| Carbonizing charges = | 76 | 6 | per shift of 8 hours = | 229 6 per day. |

| | s. | d. | | |
|---|---|---|---|---|
| 1 Exhauster and dynamo driver | 6 | 0 | ,, | |
| 1 Exhauster assistant | 4 | 0 | ,, | |
| 4 Boiler men at 4s. | 16 | 0 | ,, | |
| 2 Sulphate men at 5s. | 10 | 0 | ,, | |
| Boilers, engines, &c. = | 36 | 0 | per shift of 8 hours = | 108 0 per day |

| | s. | d. |
|---|---|---|
| 2 Electricians at 7s. = | 14 | 0 |
| 1 Fitter at 7s. = | 7 | 0 |
| 1 Smith at 7s. = | 7 | 0 |
| 1 Bricksetter at 7s. 6d. = | 7 | 6 |
| 12 Labourers at 3s. 6d. = | 42 | 0 |
| Day wage men = | 77 | 6 |

The total wages for the plant in question are therefore—

| | s. | d. | |
|---|---|---|---|
| Carbonizing | 229 | 6 | per day. |
| Boilers, engines, &c. | 108 | 0 | ,, |
| Day wage men. | 77 | 6 | ,, |
| Total wage = | 415 | 0 | per day = 10·370d. per ton of coal = 1·152d. per 1000 cub. ft. |

On referring to the "Gas World Year Book" for 1905, the author finds that of all the costs published, no instance is given of gas-works where the labour cost is as low as the above. The least cost stated is for Leigh—viz., 1·97d.; the average for all the Lancashire gas-works being 2·98d. The author therefore attributes the low coke-oven cost as above entirely to the handling of a large bulk of coal and coke by comprehensive machinery.

By converting the coke-oven into a gas-retort pure and simple, and the employment of producer gas for heating the ovens instead of a portion of the gas as at present, the steam-boilers would be deprived of the hot waste gas now made use of. It is therefore necessary, in balancing the

cost of the production of gas by coke-ovens with that from the retort process, to charge against the former the boiler coal value of the waste and surplus gases. Allowing an evaporative value of 1 lb. of water per pound of coke made for the former and 3000 cubic feet per ton (540 B.Th.U.) for the latter, we arrive at a total coal equivalent of 92 tons. This, charged at 7s. per ton, would would give a cost of 1·78d. per 1000 cubic feet of coke-oven gas made. A further addition must be made to the cost of oven gas for the coke consumed in the producer fires. This has been taken at 4 cwt. per ton of coal carbonized—deducting this amount in the following estimate as being unavailable for sale. In the item for maintenance, the author has allowed each oven a life of three years. The cost of relining is taken at £45 per oven; the balance of the item being made up by general repairs to machinery, &c. The price of the coal, which would be carbonized at the pit, he has taken at 6s. per ton, as an average price year in year out. Being treated on the spot, it is, of course, free from selling and traffic charges.

*Cost of Making* 9000 *Cubic Feet per Ton of Coke-Oven Gas* 540 *B.Th.U.*

| | Per Ton of Coal. s. d. | Per 1000 Cubic Feet. d. |
|---|---|---|
| 1 ton of washed slack = 1·05 tons raw slack (5 per cent. dirt) at 6s. . . . . = | 6 3·60 | .. 8·39 |
| Cost of washing 1·05 tons raw slack at 5d. . . = | 0 5 25 | .. 0·58 |
| Wages in carbonizing, repairs, engine and boiler tending, sulphate making, &c. . . . . = | 0 10·40 | .. 1·15 |
| Maintenance: Upkeep of ovens and machinery. = | 0 1·98 | .. 0·22 |
| Stores (including sulphuric acid, lime, lubricants, and small renewals) . . . . . = | 0 5·20 | .. 0·57 |
| Fuel to replace hot waste gas and surplus gases = | 1 4·08 | .. 1·78 |
| Salaries . . . . . = | 0 1·36 | .. 0·15 |
| Purification ($H_2S$ only) . . . . . = | 0 4·50 | .. 0·50 |
| | 10 0·37 | .. 13·38 |

*Value of Residuals per Ton of Coal Carbonized and per* 1000 *Cubic Feet of Gas Made.*

| | Per Ton of Coal. s. d. | Per 1000 Cubic Feet of Gas. s. d. |
|---|---|---|
| 70 per cent. of coke = 14 cwt., less 4 cwt. used by producers = 10 cwt., at 12s. per ton = | 6 0 | .. 0 8.0 |
| 1 per cent. of sulphate of ammonia = 22·4 lbs. per ton of coal, at £12 per ton . . . = | 2 4·8 | .. 0 3·2 |
| 4·5 per cent of tar = 100·8 lbs., at 19s. per ton. . . . . = | 0 10·25 | .. 0 1·1 |
| | 9 3·05 | .. 1 0·3 |

It will be seen from the above figures that, deducting the value of the residuals, the net working cost of making a low-grade gas from a low-grade coal by carbonization in bulk at the pit-head would be approximately 1d. per 1000 cubic feet. Adding depreciation, rates, and taxes, the cost of the oven gas up to leaving the works would be from 4d. to 5d. per 1000 cubic feet. This gives a cost for a gas of 540 B.Th.U. of from 0·74d. to 0·92d. per 100 B.Th.U. per 1000 cubic feet. The calorific value of the gas at two works mentioned in the "Gas World Year Book" is known to the author, and the cost there per 100 B.Th.U. per 1000 cubic feet is respectively 1·77d. and 2·16d.

In view of these figures, he would suggest to this Institution that, from considerations of economy of the country's coal supply and the generation of a cheap lighting gas upon a calorific standard, the attention of gas engineers should be called to the subject of the manufacture of gas from cheap coal at the pit-head by the employment of carbonization in bulk.

## Discussion.

Mr. T. Glover (Norwich) said he had taken some interest in the question of carbonization; and he thought it was very courteous of Mr. Schlicht to recognize the work he did last year. They owed a debt of gratitude to the President for having brought the matter before the Institution some years ago; and he always felt that the paper then submitted was too little understood. Whenever he (Mr. Glover) visited a colliery district, and saw what was going on with regard to the installation of coke-oven plants, he felt that they could not, as gas makers, afford to ignore what was being done in the way of carbonization in bulk. The evolution of gas-works had resulted in their dealing with coal in very small quantities. At the most, they put into a retort 8 cwt. at a time; while the coke maker put in tons at a time. He made gas from an inferior kind of coal; and he made tar products and ammonia just as the gas maker did—the only difference being that the tar and ammonia were his prime products, while gas was his bye-product. He proceeded to strip his gas, and returned 70 per cent. of it to the oven to heat it. To his mind, it seemed a great pity that such excellent gas, which was so suitable for general distribution, should be used for the heating of coke-ovens. They wanted it for supplying to their consumers. The coke maker was a competitor of theirs. He was every year putting on the market a greater quantity of tar and ammonia, and thereby depressing it. But they did not all live near to the pit's mouth; his own city was removed a very considerable distance from the coalfields, and the demand for blast-furnace coke was extremely limited in East Anglia. It suggested to his mind that there might be benefits to be derived by carbonization in bulk; but they could not in general practice imitate the coke maker. There might be—he was pretty certain there was—a half-way house which would suit many of them, and it was that they should be able to make a superior coke to that which they were now producing, and obtain a better price for it. They might be able to reduce the carbonization charges very considerably while turning out the same quantity of ammonia and tar—possibly of a superior quality compared with what they were producing now, and that they would make approximately the same volume of gas as at present. He hoped the authors of the three papers before the meeting would forgive him if he did not follow their papers, but rather presented the matter from the gas maker's point of view. He thought that they were all of them deeply indebted to Mr. Schlicht and Mr. Bury for their intensely interesting and valuable contributions to the literature of this subject. The value of the papers would not pass away in a day. They would be included in their volume of "Transactions," and used for reference; and he hoped great things would come from them. Unfortunately, he had not had time to put down the debits and credits that might arise from the use of modified coke-ovens which could be worked in a group within either their present or modified bench arches, and heated with producer gas made either from cheap slack or from coke breeze or nuts—selling the best coke at the very highest price they could get. Taking the best carbonizing results, on an average, at 11,000 cubic feet per ton, and supposing that with the coke-oven system they could only make 10,000 cubic feet, it might be taken that they would lose 4d. per ton of coal for that 1000 cubic feet. He thought this would be found to be right, *minus* the wages. The thickness of the charge was a very important matter, and one which they could not decide without making some experiments. If they would imagine a modified coke-oven 12 inches wide, the thickness of the charge would require a larger fuel consumption per ton of coal. Allowing ½ cwt. of coke additional for fuel per ton of coal, and calling it 6d., they had 10d. as a debit against the coke-oven system. But what were the credits? These would depend upon circumstances, and would vary in every district. But he had been told by those who were in the trade, that if he could make a coke of a certain quality to be used by the ironfounders, by maltsters, and others, he could obtain 10s. per ton more than he did at the present time. Then they had at once 5s., and they could depend on the reduction of wages for meeting the 4d. So that, under some circumstances, they might have credits to the amount of 5s. 4d. and debits of 10d., leaving a net balance of 4s. 6d. per ton of coal. This was worth striving for; and he thought that in the near future the Carbonizing Committee appointed by the Council of the Institution (of which he was a member), would find it well worth their while to investigate this matter. They might regard Mr. Bury's conclusions as being very important. This gentleman spoke of much lower temperatures than those they were accustomed to deal with. If they converted his 900° C. into Fahrenheit, they would find that the temperatures he had given were much lower than those generally employed; and, therefore, if he had based his products in the coke-oven on such temperatures, he (Mr. Glover) thought they were entitled to expect a very much greater yield, even if the coke was carbonized in modified ovens, than the figure he had stated. This, to his mind, gave hope for the coke-oven system of carbonization.

Mr. J. P. Leather (Burnley) said he was surprised to find that Mr. Bury had been anticipating a work to which he (the speaker) had been putting his hand, but had not yet done anything with—viz., making experiments on the carbonization of coal on the laboratory scale. Some people thought that a thing must be done on a large scale; but he believed that experiments on quite small quantities of coal,

somewhat on the lines Mr. Bury had stated, were calculated to give them information as to what they ought to aim at. They wanted to find the conditions under which they could obtain the best results from their coal and the best temperature at which to work. It only wanted carrying out more fully than Mr. Bury had done. His figures were very interesting; but he (Mr. Leather) did not wish to say anything about them. He was interested in the chart which showed the increase in the quantity of marshgas. That was of more use than hydrogen; and if going up to higher temperatures of carbonization meant that they were bringing their marsh gas down, they were moving in the wrong direction. Though Mr. Glover had spoken about Mr. Bury's temperatures being lower than those to which gas makers were accustomed, it might, after all, be better to keep them lower. A temperature of 1400° Fahr. would probably prove to be the one that would give the best results, taking into consideration quantity and quality. He thought this was borne out by Mr. Bury's chart, in which he showed that the marsh gas came down so much when they had a temperature between 700° and 800° C., which was equal to 1400° Fahr. They were all much indebted to Mr. Bury and Mr. Schlicht for their papers. That of Mr. Schlicht was more of a financial than an engineering character. Mr. Bury's experiments appealed to him more from a chemical point of view; and he felt that he must try whether he could not possibly do some experimenting to add to the information the author had given them. They wanted more information on the question of carbonization; and he hoped that all who had any opportunity of making experiments would do so, and assist the Carbonization Committee of the Institution in bringing out some practical results.

Mr. R. M. Searle (Rochester, N.Y.), as one who was somewhat familiar with coke-oven operations, having investigated a number of these plants in America, wished to say that a vote of thanks was due to the coke-oven people for the prominence they had given to the carbonization part of their business. They had spent enormous amounts in bringing it to a state of perfection; and with coke-oven plant in the hands of the old-time English gas engineer, it must become cheaper. He wished to take exception to the statement which had been made that the coke-oven people had reduced the price of residuals. Gas engineers themselves had done much to reduce it. He should like to point out that in many gas-works there were to be found several uses for their residuals which would maintain their price. It was to their interest to get the figure as high as they could, because it was their business. In America, at the present time, they were burning tar to hold the price at the market value to help them to make it in small quantities.

Mr. E. Allen (Liverpool) remarked that the papers by Mr. Schlicht and Mr. Bury were both valuable, and should be studied very carefully. The painstaking way in which Mr. Schlicht approached the question was worthy of great admiration; and he (Mr. Allen) did not think that gentleman had said the last word in respect of the cost of carbonizing. In his paper there was a table showing the number of men employed in coke-ovens dealing with 400 tons per 24 hours; and it gave the figures as 34 for ovens and 75 for retorts. Since Mr. Schlicht had made his inquiries, he thought they could put the figure of 34 down to retorts as well as to coke-ovens. Subsequently there was given the cost of each shift; and he (Mr. Allen) thought they had now a machine that would do with gas-retorts the work at the figure (8·8d.) stated for coke-ovens.

Dr. Harold G. Colman (London) said the subject of carbonizing in bulk had always appealed to him very strongly. They had all felt that the small charges they put into the retort could not represent the final method of carbonization, and that the time must come when a larger bulk would be adopted. The tendency of all recent works, in the last few years, whether with regard to carbonization in bulk or in coke-ovens, went to show that before very long the bulk in which the coal was treated, even for gas making, would be very largely increased. With regard to coke-oven carbonization, the difficulty had always been that the gas, which was the primary object of the gas maker, was not very good. He used the word town "gas" as representing the quantity multiplied by the quality. Recent work in vertical retorts in small-scale carbonization was tending to one very important conclusion—viz., that the most important fact from a gas-maker's point of view was the manner in which the gas that was primarily formed as the result of carbonization was subjected to further heat. The success of the vertical retort in Germany, so far as could be judged at present, lay not in the fact that the retort was set on end, but in the fact that it was quite full of coal, and in the condition that in the relatively small retort the gas travelled from the circumference up through the centre of the mass. It was in this that the great improvement in carbonization had taken place. With regard to the coke-ovens, it appeared to him that, finally, success would depend upon their getting in the big mass of coal the right conditions for the travel of the gas after it had been produced. There could be no doubt that they did not get the right conditions in existing coke-ovens. For the most part they were using wet slack; and when this got into a pasty mass in the preliminary stage, the gas did not travel through the cooler portions as it did in the vertical retort. If they could in the coke-oven bring about the proper conditions for ensuring the travel of the gas so that it had the proper amount of cracking, so much the better. In order to obtain the best results, they must learn what was the right amount of cracking. Anything extra involved loss, as well as great worry to the gas-maker, as all who had experienced trouble with thick tar in a retort-house would know. He saw no reason why the tar should not be of much better quality, in the sense of freedom from free carbon, or why the gas should not be of a higher yield and calorific power than was obtained at the present time; and possibly there might be an increase in the quantity of ammonia produced.

Mr. Schlicht, in reply, said he had expected to get more blows than he had received; and consequently he was not at all worried. The experiments carried on in the coke-ovens referred to had great value for him, because they enabled him to compare results obtained with what he considered the old appliances with those obtained in improved plant. The United Otto ovens shown in the paper were erected for the purpose of making gas. The ovens used by Mr. Bury were erected primarily for making coke. He had been investigating the ovens designed to produce gas, and he was waiting to make tests in them. He had long ago abandoned tests in the metallurgical coke-oven, which was badly designed from an engineering standpoint. Referring to the Otto oven—from which gas was being supplied to twenty or more cities, and which was not by any means the height of their ambition—they did not get the poor gas Dr. Colman had referred to. In the appendix to his paper it would be observed that the gas made in the first hour averaged 20-candle power, and during the different hours it decreased in luminosity. The curve which had been referred to showed that there was some resemblance between the retort gas and the oven gas. No matter what results were obtained in these ovens, they did not, to him at least, have a bearing on the coke-oven for gas production, because they were metallurgical coke-ovens and not gas-ovens. He was very greatly indebted to Mr. Glover for the kind remarks he had made with regard to him. He had read and re-read Mr. Glover's paper with very considerable interest, and had expressed the hope that he would be present at that meeting. He wanted to say a few words with regard to leakage and to the inferior gas results obtained by Mr. Bury and others in metallurgical coke-ovens. It was entirely due to a system of heating which was so poor that a gas engineer would never have designed it. It was designed by people who did not care about gas; they wanted white heat. This was not the kind of apparatus to use for testing. He might say that $1,000,000 had been spent for the perfection of gas-ovens in America, and it was in this sort of oven that the results he was talking about were produced. They were superior to any ever obtained in America in gas-retorts, copied from those made in England, Belgium, and Germany. He had tested gas in the plant of the Indianapolis Gas Company, which might be described as being up-to-date. The hydrocarbons were cracked during the different periods; the coke was bad; and so was the luminosity of the gas. They got cyanogen, and plenty of it, but they did not know what to do with it; and they also got 30 per cent. of soot in their tar. The trouble with the metallurgical coke-oven was that the man who originated it wanted to get a coke out of coal which it was not easy to carbonize in beehive ovens. This was how the coke-oven business started. Until recently, it had been believed that the beehive oven coke was the best in the world; but it was found that a harder coke could be made. In Baltimore, at the Sparrow Point works, they were to-day making metallurgical coke and gas which had the necessary luminosity to meet all requirements. The

cause of so large a percentage of nitrogen in coke-oven gas was the very defect of heating he had pointed out—viz., the alternate heating of half of the oven every half-hour. It would be noticed that when they raised the temperature of one side of the oven 300° C. over that of the other side, there must be great strain on the brickwork. He knew that the Hoffmann ovens showed 16 or 17 per cent. of nitrogen after they had been run. The Hoffmann Company had discarded them because of the alleged defects, which were common to the oven in which Mr. Bury made his test. The uneven heating of the oven charge had very much to do with the decomposition of the hydrocarbons. As he had pointed out, the Otto people, Collin of Dortmund, and Coppée of Brussels, were all aiming for uniformity of temperatures to heat the whole body of coke simultaneously. Let them think of the difficulty of heating half at a time. First they heated the centre, and then finished by heating up the ends at the expense of the middle portion. This was the metallurgical method of carbonization. They should not talk about this with reference to the gas-oven, which was a different proposition entirely. This was what he was interested in. Dr. Schniewind was a very able chemist indeed, and he deserved great credit for what he had done; but as he was not a heat engineer, he did not understand the importance of heating the charge of coal properly. If he had served an apprenticeship in a retort-house, he might know something about it. Mr. Bury and other speakers had referred to the point that in a bye-product coke-oven they could use coal that one would not buy. In New Jersey, at the present time, they were raising coal that would not be considered fit for gas making. They were buying it $1 per ton cheaper, and were getting gas of the required illuminating power. This was gas practice—not metallurgical coke practice. Their tar was better, their distillates were better, and their yield of ammonia was from 25 to 35 per cent. better. Dr. Colman had referred to the thickness of the charge, and had said that great improvements could be made in this direction. This was quite true. He was thankful for the figures Mr. Glover had given, as they showed that, instead of his estimate exceeding what coke-ovens would do, he was about 1s. below them.

Mr. Bury, in reply, said Mr. Schlicht had drawn a distinction between the metallurgical coke-oven and the gas-oven. Would he tell them what was the percentage of illuminants in the gas he obtained from the latter.

Mr. Schlicht referred Mr. Bury to the last part of the appendix to his paper.

Mr. Bury asked what it would average.

Mr. Schlicht said he did not know. What he was interested in was what the candle power of the gas would be. He was always very careful to have this taken. If Mr. Bury glanced at the appendix to the paper, he would see that the illuminants were quite high the first hour, and that they decreased down to the 25th hour. The marsh gas was at first 46·9, and ran down to 17·7; the hydrogen was 25, and went up to 65. He supposed that he had made 25 or 30 different tests to show this, so that he had never troubled about the average.

Mr. Bury said he had taken the illuminants throughout the carbonization, and with his poor metallurgical coke-oven had obtained as much as 6·5 per cent. the first hour. Mr. Schlicht had said that the percentage of nitrogen was due to the uneven heat. This required to be proved. The increase in the nitrogen was much more likely to come from the air. He believed Mr. Schlicht said that Dr. Schniewind's experiments were carried out with a metallurgical coke-oven. Of course, Dr. Schniewind was the first man to introduce this work from America; and, indeed, he was the pioneer of coke-oven gas for illuminating purposes.

Mr. Schlicht added that the effect of the uneven heating produced fissures in the brickwork. He had himself quoted tests made by Dr. Schniewind, but in the report to which Mr. Bury was referring he had just completed an oven which became the basis of the new oven. In the Otto-Hoffmann oven, he obtained such good results that he recommended the building of the ovens in a large colliery concern. He was present when the tests were made for the Moreland Steel Company for the utilization of steam coal to make gas to be supplied to Baltimore. It was these metallurgical coke-ovens that were in use to-day in that city, as well as in Boston. But Dr. Schniewind had turned his back on this class of oven. The greatest credit was due to that gentleman, who was the pioneer in America in seeking to make a good illuminating gas with the Otto-Hoffmann oven.

## GAS COMPANIES AND INCIDENCE OF RATING.

In the portion of the Inaugural Address of Mr. Charles Hunt at the opening meeting of the Institution of Engineers last Tuesday, in which he dealt with the subject of "Taxation without Representation" (*ante*, p. 796), he interpolated a few remarks on the subject of the incidence of rating as affecting gas companies. He said he had only that morning obtained information as to the percentage of profits paid in the form of rates by trades other than gas. While the amount paid by gas undertakings amounted to 7 or 8 per cent., he found, taking some twelve or fourteen other trades—such as bakers, butchers, drapers, &c.—they paid only from ¼ per cent. to 2 per cent. of their profits in rates. Thus gas and water undertakings were in the unenviable position of paying a much higher percentage in point of rates than any other industry.

The information was furnished by the following statement, issued by the South Metropolitan Gas Company, showing the actual gross receipts of various trades in South London, together with the amounts paid in rates and the percentage which the local rates add to the cost of the articles sold.

| Trade. | Gross Receipts or Gross Turnover. | Total Amount of Rates Paid Per Annum. | Percentage of Rates Paid on Gross Receipts. |
|---|---|---|---|
| Baker | £4,363 | £38 0 0 | 0·871 |
| Do. | 2,158 | 15 0 0 | 0·695 |
| Butcher | 11,440 | 28 0 0 | 0·2447 |
| Do. | 1,872 | 15 0 0 | 0·8012 |
| Chemist | 454 | 21 0 0 | 4·625 |
| Coffee shop | 3,009 | 22 2 0 | 0·734 |
| Draper | 20,000 | 74 0 0 | 0·370 |
| Do. | 8,760 | 69 0 0 | 0·787 |
| Do. | 10,950 | 155 0 0 | 1·415 |
| Forage contractor | 27,725 | 56 0 0 | 0·2019 |
| Fruiterer | 3,450 | 52 0 0 | 1·507 |
| Grocer | 1,560 | 12 9 0 | 0·769 |
| Greengrocer | 676 | 18 0 0 | 2·662 |
| Gas-fittings shop | 47,753 | 388 0 0 | 0·8125 |
| Do. | 13,958 | 267 0 0 | 1·913 |
| Lithographer | 4,565 | 47 0 0 | 1·0295 |
| Public-house | 3,250 | 117 0 0 | 3·600 |
| Do. | 6,478 | 176 12 0 | 2·726 |
| Do. | 4,182 | 93 15 0 | 2·241 |
| Sweets and tobacco | 1,040 | 14 5 0 | 1·370 |
| Timber merchant | 12,000 | 32 12 0 | 0·271 |
| Do. | 18,830 | 204 0 0 | 1·083 |
| Tobacconist | 5,215 | 62 12 0 | 1·200 |
| Totals. | £213,688 | £1977 18 0 | Aver. 0 925 |

It will be seen that the total amount of rates paid per annum equals 0·925 per cent. of the gross receipts. Those of the South Metropolitan Gas Company equal no less than 6·6 per cent. of the amount paid for gas.

## GAS STOCK AND SHARE MARKET.

**(For Stock and Share List, see p. 1023.)**

The week just closed brought fresh troubles without any mitigation of the old ones. The first was quick to make its appearance; for Monday opened with intelligence that the Duma had fallen, and much apprehension of sales on Continental account ensued, though the alarm was less intense before the day closed. But on Tuesday the agitation was renewed, all sorts of vague reports and rumours aggravated an already overstrained situation, and a record for many years past was accomplished by Consols being sold down to 83⅛—*i.e.*, cheaper than a 3 per cent. for money price. This figure was again touched on Wednesday; and the gilt-edged division in general was very weak—Home Rails especially among the rest. On Thursday, there was something of a pause, and hardly any business was done; so that movements were very slight and very irregular. On Friday, another trouble cropped up in the shape of the failure of a discount house in Alexandria, producing fresh alarm and paralyzing business. Few were sellers, and fewer still were buyers. Saturday came and went without any further thunderbolt, and the general situation was calmer. In the Money Market, there was a pretty steady demand both for short loans and discount; and rates were firm, with a tendency to further hardening. Business in the Gas Market was uneven. On some days it was quite brisk and active, and on others it fell rather drowsy. But taken altogether, the aggregate was well up to the mark. Changes in quotation were not numerous, but they were nearly all in the downward direction, thereby marching symmetrically with all other departments. Gaslight and Coke ordinary was the important exception. In it, there was a considerable amount of business at prices which ranged from 92 to 93—a rise of ½ in the quotation. The secured issues were unusually busy; the maximum changing hands at from 87¼ to 88½, and the preference at from 102½ to 104. Nothing, however, was done in the debenture. South Metropolitan was affected by the announcement of the rise in the price of gas, and the consequent reduction in the rate of dividend. Dealings opened on Monday as

high as 122; but on Saturday 118 was marked—a fall of 2½ in the quotation. The debenture was done at from 83½ to 83⅞. Nothing was marked in Commercials except one deal in the debenture at 82—a fall of a point. In the Suburban and Provincial group, Alliance new changed hands at 14¼, Brentford new at 189, Hastings 3½ per cent. at 95 and 98, West Ham ordinary at 104½ and 104¾, and ditto preference at 120 and 122¼. South Suburban ordinary was marked down 1½; and Liverpool "A" fell 1 locally. Not much was done in the Continental Gas Companies. Imperial ranged from 171½ to 170, European fully-paid marked 23½ and 23 (a fall of in both issues), and Union was not dealt in. Tuscan marked 10$^{9}/_{16}$. Among the undertakings of the remoter world, Bombay marked 6¾, Buenos Ayres 11¼, Cape Town 11, Primitiva 7$^{1}/_{16}$ and 6$^{15}/_{16}$, ditto preference 5$^{1}/_{16}$ and 5 (a fall of ¼), ditto debenture 94 and 94½, River Plate from 12⅞ to 13⅛, ditto debenture 95½ and 95¾, Melbourne 5 per cent. 101 and 102, and Oriental 146.

## THE FOURTH ENGINEERING CONFERENCE.

The Fourth Engineering Conference of the Institution of Civil Engineers was held last week in London, and was, it is hardly necessary to say, largely attended. The sittings proper covered three days—Wednesday, Thursday, and Friday—though the fifteenth "James Forrest" lecture, which was delivered on Tuesday evening, may be regarded as part of the proceedings. The lecturer was Mr. Francis Elgar, LL.D., F.R.S.; and the subject was "Unsolved Problems in the Design and Propulsion of Ships." A long programme had been prepared for the conference, which was divided into seven sections; and the discussions which took place were of a helpful character.

### Address by the President.

Before, however, the sections commenced their work on Wednesday morning, the members all met together in the theatre of the Institution, where they were briefly addressed by the President (Sir A. B. W. Kennedy, LL.D., F.R.S.), in opening the proceedings. He pointed out that the first of the conferences was held in 1897, under the presidency of Sir John Wolfe Barry; the second in 1899, under Sir William Preece; and the third in 1903, under Mr. Clarke Hawkshaw. The present was therefore the fourth of the series; and he hoped that it would not be the least interesting and useful. The conference had many objects. It brought together more members than could otherwise meet at any one time; it allowed members to take part in the proceedings of the Institution who would otherwise have little opportunity of doing so; it permitted them to compare notes on a great variety of subjects in a useful, although informal manner, and in a very short space of time; and it gave opportunity to all of them for pleasant social intercourse with those who were their colleagues in every-day work. In spite of the very extended ground covered by the subjects of the sections, it was only the Institution's own members who were asked to meet and discuss them; they did not need, fortunately, to go afield beyond their own borders to find men, not only interested, but distinguished, in every single department of engineering work. Judging from what he had seen of the programmes of the business, as they had been arranged by the officers of the different sections, there was no doubt that engineering matters of great importance were to be brought forward. In asking the members to proceed to the proper and subdivided business of the conference, he reminded them of the scheme which was intended to be carried out. The papers to be read were simply "notes," strictly limited in length, and meant rather to open discussion and to promote it than to be any formal and complete statement on their particular subjects. The reading of each note was expected to occupy not more than about ten minutes; and the opener being thus limited in time, the subsequent speeches would be similarly or still more limited. He then declared the Fourth Engineering Conference of the Institution of Civil Engineers to be in session.

### SECTION VI.—WATER-WORKS, SEWERAGE, AND GAS-WORKS.

Wednesday's proceedings of this section consisted of the consideration of subjects appertaining to water-works. The Chairman of the section was Sir George Livesey; but at his earnest request Dr. G. F. Deacon consented to take the chair during the transaction of the water-works business. There were three papers down for reading; and the first taken was one on the "Comparative Cost of Pumping by Steam, Internal Combustion Engines, and Electricity, based upon Actual Working," by Mr. Charles Hawksley and Mr. Henry Davey. The other two papers dealt with "Water Softening" and "Water Hardening," and were by Mr. W. Matthews and Mr. J. Watson respectively. These we may have an opportunity of noticing subsequently.

### The Papers on Gas.

Thursday was the day set apart for the consideration of matters relating to gas supply; and two papers were presented. The first of these was entitled "The Applications of Towns Gas as a Heating Agent," by Mr. W. H. Y. Webber; and the second "The Distribution of Gas at Increased Pressure," by Mr. Charles Carpenter. These papers, with reports of the discussions to which they gave rise, will be found on pp. 993-96 to-day.

Sir George Livesey occupied the chair; and in introducing the business he remarked that unfortunately this week happened to be the date of the annual meeting of the Institution of Gas Engineers, which was being held in Dublin, and the majority of the gas men of the country were over there. All he had to say at the outset was that Sir W. B. Richmond, speaking on "Smoke Evils," said, according to the "Tribune," that our late springs and early autumns were caused by London smoke, and nothing else. One of the great objects of the London Gas Companies—and of all gas companies, he might say—was to act as agents for the prevention of smoke; and they believed that cheap gaseous fuel was the best and most convenient thing for this purpose. The difficulty was about the price of it; for to bring it into general use, it was necessary that gas for heating should be sold at as low a figure as possible. Now, the trouble of the gas companies was that everything seemed to be against them in trying to sell gas at a low price. There were the constantly recurring (at shorter intervals) booms in the coal trade, by which the cost of coal was increased to an enormous extent; and consequently the price of gas had to follow. Then the parochial authorities, and people of that sort, were all anxious to get as much as they could out of the gas companies in the shape of rates. Gas and water were rated more heavily than other articles in common use. He had had inquiries made, and found that the rates the consumer paid in his butcher's, baker's, and similar bills were on an average less than 1 per cent. of the price he paid for the goods; but with gas the figure ranged from some 5 to 10 per cent.—all of which, or very nearly all, the consumer had to pay. This militated against any reduced price. When they could induce the authorities to see that it was to their interest, to the interest of the public, and to the interest of everybody to work with the gas companies towards the production of gas at the lowest possible price—when they had succeeded in doing this, they might hope to see gas cheaper than was now the case. Public authorities and others could not understand the system under which gas companies worked. The majority of them were under what was known as the sliding-scale, which made it to their interest to sell gas at the lowest possible price. There were, of course, companies who were not under the sliding-scale—in fact, some of the cheapest gas in the country was sold by a company who were only under the sliding-scale to a limited extent. He referred to Sheffield, who were allowed to increase their dividend to 10 per cent.; but beyond that there was no further increase. The public could not appreciate the fact that gas supply was on a different footing from other products, the chief object in regard to which was to sell at as high a price as possible. They were anxious to sell gas as cheaply as they could, because from a business point of view they were subjected to very severe competition; and this could be met best by a low price. They were now attacked from another side. They were wishful to promote the use of gaseous fuel to prevent the production of smoke; and during that week, there had been issued the prospectus of a Company formed to erect works in London and carbonize 3 million tons of coal a year. This was as much coal as the three great London Gas Companies—the Gaslight and Coke, the South Metropolitan, and the Commercial—carbonized in a year; and these people talked very glibly about doing this for the production of a new fuel, as they called it. It was not for him to say anything about that, as any remarks he made might be supposed to be interested; but there was nothing to prevent gas companies selling a coke that would answer the same purpose, and what this Company were going to do then he did not know. He was told that if gas companies tried to sell coke of the sort, the new Company would attack them. All the better; for then they would see if the patents which had been kept a secret up to the present were worth the paper they were written on.

Mr. Webber was then called upon to read the remarks which he had prepared with the object of promoting discussion. Later on Mr. Carpenter read his paper; and a vote of thanks was passed to both authors for their contributions.

Sir George Livesey said there was nothing new in the gas industry except vertical retorts. There was an installation of these at the Nine Elms works of the Gaslight and Coke Company. The idea was, of course, not new, because vertical retorts were proposed generations ago; but it seemed that now they were coming into practical use. The installation at Nine Elms would be open for inspection that afternoon.

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**Arsenic-Free Gas Coke.**—In our "Register of Patents" to-day will be found an abstract of the specification of a patent taken out by Messrs. Drinkwater and O'Connor for the manufacture of coke free from arsenic. Many of our readers will probably remember the scare which occurred some time ago on the subject of arsenic in beer, the result of which was that maltsters and brewers had to refrain from using gas coke, owing to the arsenic it contained. By the new process, which is exceedingly simple and inexpensive, the quantity of arsenic is brought down to that found in the best anthracite coals; and in consequence the value of the coke is increased by some 2s. to 3s. per ton. A sample of coke after treatment was submitted to Dr. Miller, of Manchester (the recognized authority on arsenic-free fuels), who found that it contained no volatile arsenic, while the quantity of fixed arsenic was inconsiderable. We learn that arrangements are being made by the Arsenic-Free Coke Syndicate—a recent registration in Edinburgh—for granting licences to use the process, either for any one works or for districts.

# TOWN GAS AS A HEATING AGENT.

By Mr. W. H. Y. Webber.

[A Paper read at the Engineering Conference on June 20.]

The general recognition of ordinary town gas as primarily a fuel dates only from the year 1900, when, upon the initiative of the South Metropolitan Gas Company, the traditional supremacy of the illuminating-power standard of quality for this kind of combustible gas was overthrown by Parliament. Before this epoch, although certain distinctly fuel uses of gas—as for cooking and heating—had become well established on the domestic scale, and were even favoured by public caterers, gas was not included among industrial fuels. The heat of gas, when burnt for lighting, was formerly regarded rather as a disadvantage; and even gas manufacturers generally gave no thought to the calorific value of their product, of which no account was ever taken.

The great change of technical opinion in this regard sprang from the conviction (which I was among the first of English gas engineers to embrace and declare, in the year named) that not only had the Welsbach invention of incandescent gas lighting come to stay, but it had also revolutionized the principles of gas manufacture; for the Welsbach light, in all its varieties and developments, was clearly a temperature effect. It offered an immediate advantage of tenfold the light for the same quantity of gas consumed by means of the ordinary burners of the period—an advantage since doubled; and the discovery was made that the luminous efficiency of the Welsbach mantle is, within considerable limits, independent of the quality of the gas as expressed by its natural illuminating power with the luminous flame.

The importance and far-reaching character of this revolution in the whole polity of the gas industry quickly asserted itself. The expensive practice of artificially enriching gas with hydrocarbons to make it show a brilliant luminous flame at the statutory testing-stations, fell into discredit; and only recently that Parliament liberated the industry, in London and other towns, from the bonds of a meticulous standard of purification which has always given more trouble than it was worth. The gas calorimeter is now used in every important gas-works; and engineers have acquired the habit of talking of their product in terms of calorific value.

Meanwhile, gas companies and gas committees of municipal corporations perceived the industrial prospects of gas in a new light, as a fuel and source of motive power for town workshops and factories. The study of calorimetry proved useful for the effective comparison of towns gas with suction producer gas, and other gaseous combustibles belonging to what were formerly classified as "fuel" gases. Likewise, the study of the load-factor effect on gas manufacturing costs conduced to the granting of discounts, on a liberal scale, to large consumers of gas for power generation and industrial purposes. Producer gas having only about one-fourth to one-fifth of the heat value of the cheapest towns gas, being of uncertain composition, and requiring 20 per cent. more cylinder capacity for the same effective horse power (besides being dangerous to life and creating a nuisance), does not make headway against towns gas at 2s. per 1000 feet.

The domestic uses of gas for cooking, heating, and the warming of water have been greatly favoured by the prepayment meter system. In London, probably the majority of householders, and most restaurants and houses of business, cook by gas. The Gaslight and Coke Company systematically instruct their consumers in the use of gas-cookers in their own homes. The hiring-out of all descriptions of gas cooking and heating apparatus is almost universal. The popularity of gas-fires and other uses of gas received a strong impetus from the International Gas Exhibition held at Earl's Court in 1904; and recently a marked improvement has been effected in the design and construction of the so-called "fires," in which a light form of refractory material is heated to incandescence by atmospheric gas-flames. By the adoption of Siemens's principle of free-burning flames without contact, effective heating without the escape of noxious interconal gas is assured. Hitherto, the cost has proved an obstacle to the general use of gas-fires; but with the gas consumption reduced to 20 cubic feet per hour, the expense of occasional fires in a household does not compare unfavourably with coal, more especially if additional servants' wages are considered. Hotels are being converted to the use of gas-fires. There is yet plenty of room for improvement in these articles. Gas-steam-radiators are the latest type of gas heating-apparatus, and are very effective. Gas-heated water-circulators, of recent introduction, are already well received by the public—being in every respect an improvement on the usual kitchen-range boiler. Their efficiency is high. The same good character may be claimed for modern rapid water-heaters of the "geyser" type. Small gas boiling-burners have a relatively low efficiency, ranging from 40 to 50 per cent. of the power of the gas. All these gas heating-appliances require a pressure to be maintained on the supply of not less than 1½ inches nor more than 2½ inches of water at the point of combustion. Simple governors, and gas and air adjusters, are desirable so as to ensure good working conditions when the main pressure is higher than this figure.

The modern conception of towns gas as a powerful, clean, convenient, and not prohibitively expensive fuel, has already borne fruit in many forms of industrial gas-furnaces. Some of these are low-pressure appliances, worked directly off the street-mains, which, however, now usually carry much higher pressures than formerly. Hitherto, pressure in gas distribution has meant the head necessary to transmit gas to its destination in sufficient quantity. But recent developments have imposed another function upon pressure; and if there is any new point in this note, it is that in the potentiality of towns gas to attain any degree of temperature required for an industrial purpose, by increase of pressure at the burner, there lies awaiting development a new and valuable asset of the gas industry. I do not propose, therefore, to occupy any of the extremely brief time at my disposal with a recital of the familiar facts of unassisted-pressure gas-firing; but to draw attention to what has actually been accomplished with specially increased gas pressure, to meet the necessity of means for the attainment of very high temperatures at points in a large works, irrespective of the source of heat, obtainable at any hour, and without risk of explosions in the combustion-chamber.

The requirement pressed acutely upon Mr. A. W. Onslow, in his capacity of Gas Engineer to the Royal Arsenal at Woolwich. Mr. Onslow had already gained experience of high-pressure gas for lighting, as one of the inventors of the Sale-Onslow system; and he first applied gas at the same pressure—53 inches of water—to solve the problem. It was found that a mass of metal could be heated by this means to 1040° C. in 4¼ hours, for a consumption of 1700 cubic feet of gas, of the ordinary 14-candle grade. By simply increasing the gas pressure to 67 inches, the same work was accomplished in 2½ hours, with only 1300 cubic feet of gas. Whereas a coal and coke furnace could deal with but four long steel bars a day, gas at 94 inches pressure, consuming 900 cubic feet per hour, heated four bars an hour. It is sometimes easier and cheaper to take the heat to the work than the metal to the furnace. Parts of a massive crank-shaft can be annealed, tempered, or case-hardened by simply building a fire-brick casing round the piece, and leading the high-pressure gas to it. Pieces of regular size can have portable fire-clay hoods fitted for them, and be tempered or annealed where they lie. Steel castings, 3 feet long and 12 inches diameter, are thus treated by flexible hose-fed burners, 100 yards distant from the pressure-raiser. The saving in labour and time by this method far outweighs the cost of the gas. High-pressure gas is also useful for burning off paint in difficult situations. It is fast coming into use on a large scale for melting porcelain, hard glass, and type metal, and for other purposes in which time is an object, and a clean, regular, and reliable means of obtaining any degree and quantity of heat at a particular spot is a prime essential.

### *Discussion.*

Mr. Thomas Goulden said it appeared to him that one of the most important points in the paper was the title. He wished it could be recognized that towns gas was a heating agent. As soon as this was understood, and that it was only through the efficiency of its powers as a heating agent that it was used for illumination, the better it would be for the public and for the gas companies as well. He had been away from England not long ago; and nothing struck him more than the excellence of the lighting in the large Continental towns that he visited. The lighting was very, very good; and he had seen nothing to compare with it here. Yet in all the towns he saw illuminating power was entirely disregarded by the engineers in charge of the gas-works. It was disregarded to such an extent that he had the greatest difficulty in ascertaining what the illuminating power was. This, in connection with the excellence of the lighting, was, he thought, a most instructive fact for them to consider here. In the towns he referred to, they looked upon the gas as a heating agent entirely; and it was solely a question of calorific value with them. They secured their light by means of heat to such an extent that in one town 99 per cent. of the gas was used as a heating agent—in engines, or for direct heating, or for the production of illumination by means of the Welsbach mantle. He thought the sooner this standard was attained here, the better it would be for everybody, because then they would be able to cater in one direction. At present, they were hampered by having to comply with illuminating power standards that were very difficult "to live up to," if he might use the term, at every spot on the district. The Gaslight and Coke Company had the greatest trouble in keeping up the illuminating power. They sent the gas out with what they considered a very ample margin; and still, in spite of that, they were continually annoyed by having to appeal against tests showing deficient power. They knew this arose from local causes, and that the illuminating power of the bulk of the gas must be higher than that which would fulfil what was required of them. If they could only work to the calorific standard—he was convinced at some time it would be the standard—and confine themselves to that one direction, they would know just where they were. It would be a better standard, because they really could determine the calorific power; its estimation did not depend upon vision. A calorific test, with a liberal margin, would be a very much better method of fixing the value of towns gas than the present plan of taking the illuminating power. This occurred to him as being the principal point of the paper, and one upon which he felt he could say something. The other matters referred to distribution; and he should prefer to leave these to be dealt with by subsequent speakers. The town to which he had alluded, in which such a very large proportion of the gas was used as a heating agent, was Dessau.

Sir GEORGE LIVESEY (the Chairman): But it is the same generally on the Continent, is it not?

Mr. GOULDEN: Yes. The calorific power was hardly so good as our gas here.

Sir GEORGE LIVESEY asked whether the gas was tested for calorific power.

Mr. GOULDEN said it was not. Their standard was 5500 calories per cubic metre; and the gross heating power was about the same as the net heating power of the gas supplied in London. It was an empirical standard they had set up themselves. There was no obligation. They were business people; and they considered that was the best article to supply, having regard to the requirements of the public.

Mr. CHARLES HAWKSLEY, referring to Mr. Goulden's remark that 99 per cent. of the gas was used as a heating agent, including lighting by incandescent mantles, asked whether there was a large consumption for lighting purposes.

Mr. GOULDEN replied that there was. The high percentage was principally due to the use of the incandescent mantle. He was told that there were one or two flat-flame burners; but he did not see any.

Mr. B. H. THWAITE said he noticed the author mentioned that the general recognition of towns gas as primarily a fuel dated only from 1900; and he thought Sir George Livesey was one of the leaders in that respect. As a matter of fact, he (the speaker) proposed this, in collaboration with Mr. Dugald Clerk in 1892 in the "JOURNAL OF GAS LIGHTING." He showed that the results obtainable with the Welsbach burner were quite independent of the illuminating power of the gas; and he suggested that the photometrical value might be reduced. He also suggested that the pressure should be increased. This was now fifteen years ago. He thought in that building many years back he brought the Berthelot-Mahler calorimeter before the Institution of Gas Engineers, and suggested that calorific power should be substituted for illuminating power. As a matter of fact, the Welsbach burner was a calorimeter itself. Twenty years ago, he showed at Manchester that the calorific power could be tested in the burner. He saw the author spoke rather disparagingly of producer gas; but he thought he ought to differentiate. Blast-furnace gas was far more uniform in calorific power than towns gas; and so was a well-designed suction gas producer. As to the heating power of towns gas for local purposes, he thoroughly agreed with the author. With high-pressure applications, one could get a tremendous heat. One could, however, do the same with producer gas with recuperation; whereas if recuperation was adopted with towns gas, it split it up.

Mr. H. A. HUMPHREY remarked that the subject of the paper was undoubtedly important; and it should receive full consideration. Personally he took a very great interest in the question of fuel gases, and he should like to see the development of towns gas as a heating agent. Having said this much, he thought what he was going to add would be taken in a perfectly friendly spirit. He was somewhat sorry that the reference to producer gas should have found place in the paper—at any rate, in the form in which it occurred. It was one of those things that contained half-truths, which were very often difficult to kill, and frequently did a great deal of harm. It was said that producer gas was uncertain in composition. Of course, this was true in the sense that there were all kinds of producer gases; but in the sense in which it was used in the paper, it was not true. He had designed the plant at the South Staffordshire Mond Gas Company's works; and he could say in connection with this that the calorific value of the gas sent out from hour to hour and from day to day was more constant than that of the gas supplied to the various townships in the district, as ascertained perfectly independently during the parliamentary inquiry before the Mond gas plant was put up. Then the author went on to say that 20 per cent. more cylinder capacity was required for the same effective horse power. This, also, was true in the sense that if one took a certain definite engine that was designed for working with lighting gas, and put producer gas in it, it would give with the same cylinder capacity from 12 to 20 per cent. less output. But if one designed the engine for use with producer gas, and it was properly proportioned, then it would give the same output per unit of cylinder capacity as another working with towns gas. He could show the author cards in which the mean effective pressure varied from 112 lbs. to 120 lbs. per square inch; and he did not think the author would readily produce any cards with engines on towns gas showing a more effective pressure. This was, of course, really the determining point. Then as to the liability to cause danger to life and to create a nuisance. He presumed that the author referred to the presence of carbon monoxide in producer gas. But the Board of Trade limited the amount of carbon monoxide that might be present in the gas to be distributed. This limit was 14 per cent.; and in the plant of which he had spoken, the percentage was about 12, and was always under 14. He thought the author would be able to instance many cases of ordinary lighting gas, where a supply of water gas was included, in which the percentage of carbon monoxide would average more than 12. In his opinion, there was room for both producer and towns gas. Fuel gas was required in both forms. Undoubtedly towns gas was very suitable for some cases—for those in which the quantity needed was comparatively small, and in which the user could afford to pay a rather higher price—but surely the author did not mean to say that for furnace work requiring thousands of cubic feet an hour, or for purposes needing thousands of horse power, people could, or would under any circumstances that could be conceived, possibly employ lighting gas. He wanted to see fuel gas go ahead; and he thanked the author for his paper.

Mr. CHARLES HAWKSLEY said he was afraid he could not add much to what was contained in the paper from a gas manufacturer's point of view; but he would like to make a few remarks as a consumer.

Sir GEORGE LIVESEY: That is just what we should like to hear.

Mr. HAWKSLEY (continuing) said that he happened as a private individual to have about fourteen gas-fires in his house, though about ten of them were in bedrooms, and therefore only occasionally used. Still, when he put them in some years ago, he wished, if ever the need arose for them all to be used together, that the pressure should not be affected. He soon found, however, that on lighting them all at once the pressure was affected, especially in the day-time; and on making tests, he discovered that his own service-pipe, when all the stoves were burning, absorbed about 3-10ths pressure, which in the case of the day pressure made a very great difference. Therefore he determined to put in a 1½-inch service-pipe; and when his fitter asked the gas company for the necessary sanction, they inquired whether it was wanted for a factory. Another thing was required in his opinion to make gas-fires satisfactory to the consumer—especially to those who, like himself, wished to see a really cheerful fire—although he knew it was wasteful in the consumption of gas. Usually the pipe leading to the stove was very small; and it was impossible to get a cheerful fire if one wanted it. He put pipes to each stove of a sufficient size to afford a good flame. He thought this really had something to do with the objection people at times had to a gas-fire—that it was a cheerless sort of thing as compared with coal.

Sir GEORGE LIVESEY: The greater part of our complaints are of want of pressure.

Mr. HAWKSLEY said that if the precautions he had named were observed, this complaint at all events would be removed. Of course, there was another complaint, which he must admit had a certain amount of truth in it—that the heat given off by a gas-fire was of a somewhat dry character, as compared with that of a coal-fire. As to cooking, forty years ago he did all his by gas; and when properly used he thought it was rather better than an open fire, because the heat was more uniform. The gas companies must be careful, in their endeavour to produce very cheap gas, not to ignore the question of quality too much. The sulphur restrictions had now been removed; but he could well remember in the days before they were imposed—about fifty years ago—he always began to cough about a quarter of an hour after the gas was lighted, owing to the amount of sulphur in it. He hoped this state of things would never recur.

Mr. JOHN HUNTER said he was not a practical gas manufacturer, but was connected with one of the oldest works in the country, which had been established since 1818. As to the quality of gas, for a long time they had endeavoured in this small works, making about 14 million cubic feet a year, to keep up the quality, for the benefit of the private consumers, to from 19 to 19½ candle power. Quite lately, however, they were in difficulties about their coal supplies, which became irregular; and when they were almost without the usual coal just about Christmas time, they had to secure some other kind, with the result that the power of the gas was reduced to 15½ to 16 candles. Not a word was said during this time, and so they continued to use the new coal. From that day, they had made gas of not more than 17-candle power; and not a word of complaint had been heard about it. The greater part of the consumption was in cottages which were fitted for gas throughout and provided with a cooker. The lighting was by incandescent burners. The consumers were perfectly satisfied; and so were the suppliers, because with the increased price of coal they were just as they were before.

Mr. KILLINGWORTH HEDGES remarked that he had tried electric radiators, and they were rather uneconomical; but this was three years ago, before the new "cut" rates were given for current used for heating purposes. He had reverted to gas-stoves; and what he wanted to ask the author was whether he could give any information as to the duty of a gas-stove. It seemed to him that, excepting the kind mentioned in the paper (gas-steam radiators), there had been very little improvement in gas-stoves in the past few years; and he was astonished at Earl's Court Gas Exhibition to see what a slight difference there was between those shown and stoves he had experimented with some years ago. He thought more might be done in this respect. One improvement he made was that, instead of letting the exhaust-pipe go straight into the chimney, he took it some distance up the wall; and by this means he got an artificial draught. He was rather surprised to find, in connection with a house where the South Metropolitan Company fitted gas-stoves on the slot-meter system, that they were a little alarmed about putting them in the bedrooms; but he must say they put in very large service-pipes, and did the work well. In this case, the stoves were fitted in the way he had suggested—with the outlet-pipe running some distance up the wall. The figures given in the paper with regard to the efficiency of small gas boiling-stoves—from 40 to 50 per cent. of the power of the gas—did not seem very high. If the author could furnish similar information with reference to heating-stoves, it would be a very valuable addition to the paper.

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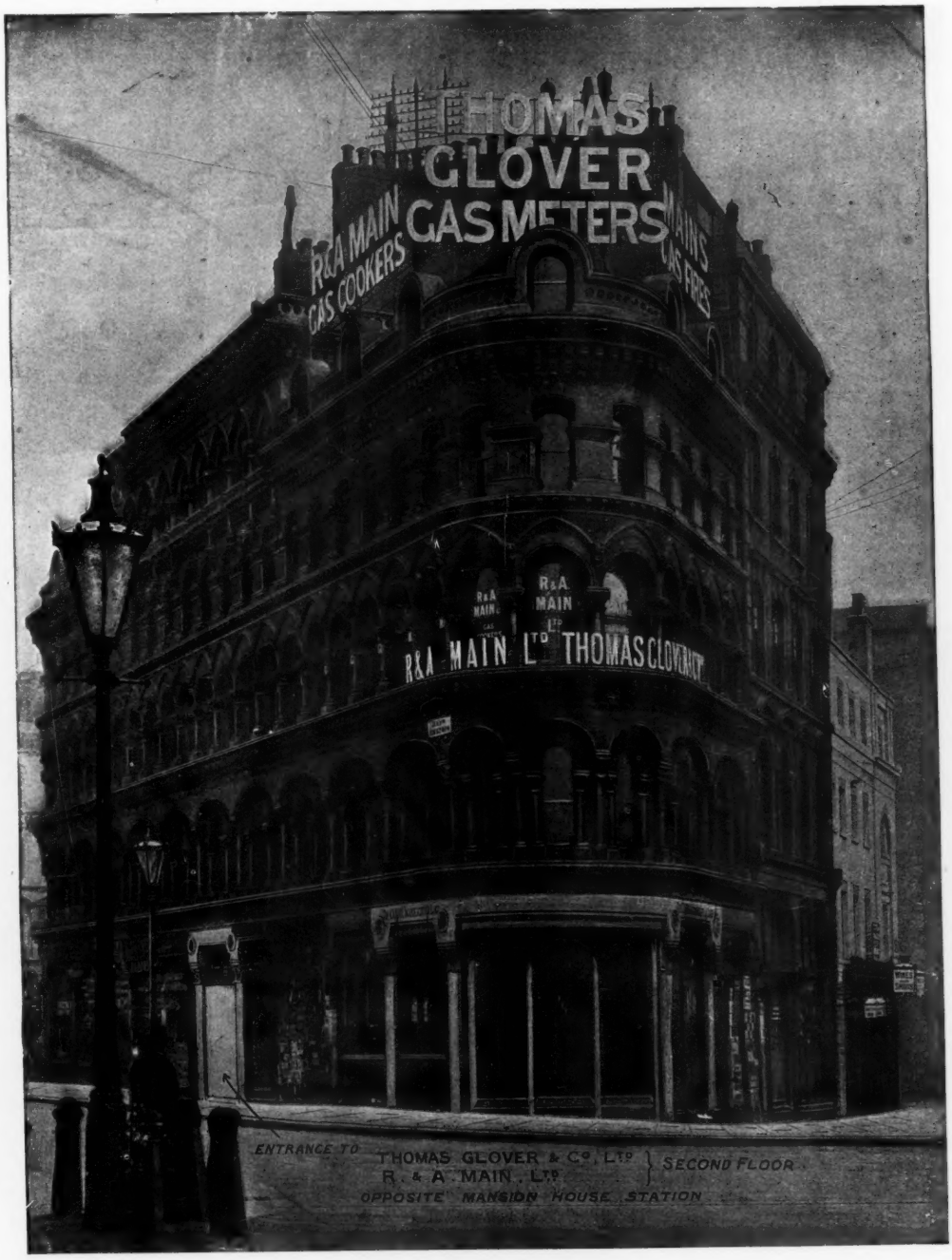


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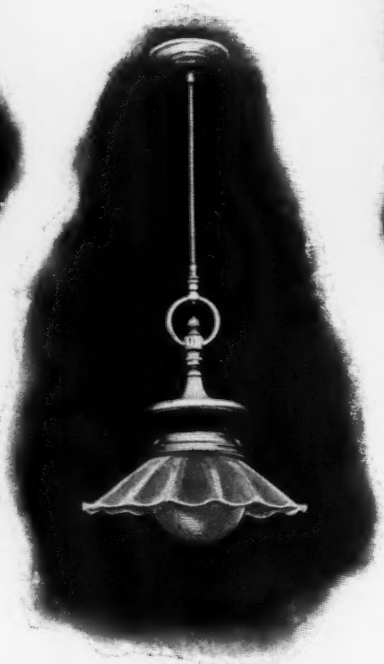

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Mr. R. G. Alford said he was not a gas engineer; and he desired some information with regard to gas-steam radiators. Could they, without smell, be used in a room not provided with special ventilation? The question of danger was very important, as they all knew of the serious accidents that had happened with geysers. The experience that he had had with a gas-radiator was that it made the whole place black. One was put in a small church, and before many weeks had gone by, everything was as black as soot. Of course, there was no danger connected with this; but he wanted to know how such a state of affairs was to be avoided, and how gas-radiators could be made effective.

Mr. S. R. Lowcock said the paper contained some reference to the application of gas for industrial purposes, for heating and melting. He should like to know how the gas was applied, because some time ago he had occasion to go into the matter for heating metal, melting brass, and that kind of thing. He found when the gas and air were mixed, and then the pressure was raised, he could obtain a fairly economical result in melting; but it was extremely dangerous, and to avoid this he tried wire gauze screens and various devices. They were, however, not altogether satisfactory; and then he tried injection burners, raising the pressure of the gas only, and taking the air in with it. But this was not at all economical; and it produced a very local intense heat, which they could not get satisfactorily distributed round the crucible, while the noise was fearful. So it was given up. The same thing occurred in connection with gas welding of steel pipes. This was carried on for a good many years with the gas and air mixed, and then the pressure raised. The same difficulty was, however, found. It was economical; but the danger was very great, and it had to be given up. It was now done with a series of injection burners, which worked satisfactorily; but there was a great deal of noise, and it was not so economical as when the gas and air were mixed and the pressure afterwards raised. His experience had not been at anything like the pressures given in the paper. The highest he worked with was 20 inches, and for welding about 7 inches. He should like to know what sort of burner was used with the pressure named by the author.

Mr. G. B. Wills, speaking as a gas director, but not a gas engineer, said he had considered the question of using gas for heating purposes; and the first thing he did was to warm his greenhouses by this means. The result had been so thoroughly satisfactory that he recommended everyone who had a small greenhouse to abolish coke and anthracite coal, and put a bunsen burner under the existing boilers. The charm was great, because one was not dependent on a man to keep the fires up. The heat could be regulated according to the condition of the thermometer. This was a great source for the use of gas all over the country; and he had induced some twenty or thirty of his neighbours to adopt it. He had had his apparatus arranged so that he could burn anything from 5 to 60 cubic feet per hour. The expense in his case came to less than ½d. per hour; and several friends were doing it for ¼d. It compared well with coal and coke.

Mr. Charles Carpenter said there were two matters which had been referred to by previous speakers that he should like to touch upon. One was with regard to the brilliant lighting of some German towns, as compared with (he believed the speaker meant) London. There was this difference, he thought; and he should like to point out what he believed to be the cause. It was due to the absence of dust in the air of the German cities, as compared with London. One of the great difficulties they had in maintaining incandescent burners in London was caused by the deposition of dust on the nipples of the burners and on the mantles. He thought this, too, answered the point raised by another speaker, who put in a gas-radiator, and was troubled with black from it. Gas was very often accused of causing this blackening of ceilings and walls; but they could not have a better object-lesson than was presented by the room in which they were then sitting. Above where every steam radiator stood, there was a large black patch. He thought the difficulty that had been referred to in connection with the gas-radiator arose from the same cause as the trouble that was experienced in maintaining incandescent burners at their highest efficiency. It was owing to dust in the air. The windows in his flat in London had to be kept covered with muslin; and in this way the blacks and dust were all caught, and twice a week were swept up in a dust-pan.

Mr. W. J. A. Butterfield said the remarks of Mr. Goulden and other speakers had suggested a few observations to him. He might say that he had had the pleasure of visiting the Cologne Gas-Works, and of seeing the large installation of vertical retorts in action. The practice there was to make the gas in these vertical retorts to a definite calorific standard. This standard was 5000 calories per cubic metre. It was lower than the English standard. They attained this uniform calorific power by carbonizing in the ordinary way without admission of steam for (say) eight hours, and then admitting steam in sufficient quantity to produce enough water gas to bring the calorific power of the mixture in the gas-holders to the standard of not less than, but as near as possible to, 5000 calories per cubic metre. This appeared to be amply adequate; and there was no question as to the good effects it gave with the incandescent mantle. The only other point on which he need make any comment was as to the pressure of gas for heating purposes. It had long been a difficulty in chemical laboratories to get sufficient pressure for heating. With many furnaces, one could perform operations with 3 inches pressure which were impossible at lower pressures. Chemists in London and other large towns had constantly, he believed, asked the gas companies for as high a pressure as possible, and had been unable to get it; but of late years there had been a great improvement. Some time ago, he knew that the faulty pressure drove some chemists to use electrical furnaces.

Mr. William King remarked that it went without saying, he thought, that it was to the interest of gas companies to supply their commodity at the very lowest possible price. Perhaps the question of the sliding-scale or fixed dividends hardly came within the scope of the paper, except as affecting the matter of supplying at the cheapest possible rate; and whatever might have been the effect of the former method, it did not perhaps apply with the same force now, owing to the fierce competition to which gas suppliers were subjected, which made it quite to their interests—whether municipalities or private companies—to sell their commodity at the very lowest price, and to give an efficient supply. He thought perhaps one of the most important points brought out that day had been mentioned by his friend Mr. Hawksley. It was no use selling cheap gas and properly supplying the mains, if the service-pipes and fittings were inefficient. His attention was called to this matter some time ago, when staying at a country house in the South of England belonging to a relative, who had recently put in gas-fires. The weather was cold, and a more miserable exhibition of gas he never saw in his life. He had no means of testing the pressure; but it seemed to him that what was the matter was that really good fittings were required in the premises themselves. If this had been attended to, he believed they would have had an excellent supply. Like Mr. Hawksley, he used gas-fires in his own house; and the size of the pipes which he had recommended the architect to put in at the time of building, had rather startled him. But the result had been that whenever friends came into the house and saw the fires, they were amazed. Therefore he thought, with regard to using gas for fuel, it was of the very utmost importance to the suppliers to see that the wretched work, a great deal of which he feared was put into houses, was discontinued, and that amply large pipes were laid in all directions, so that if the owners or the tenants wished to have gas-fires they could adopt them with a fair prospect of success.

Mr. C. E. Jones said that in his house he had only one fire that was not a gas-fire; and he had every reason to be grateful to the gas company for the manner in which they had fitted up the premises, and the excellent supply of gas which they had vouchsafed to him. A great many of the complaints which were levelled against the use of gas for cooking and heating were simply a question of the area of the pipes. Gas was first of all introduced into houses as an enemy, and then found to be a friend; and now they had only to educate the architects up to the necessary pitch to get sufficiently large pipes put in, when there would be no complaints as to the supply of gas. He should like to compliment Mr. Onslow on the excellent results he had secured at Woolwich by increasing the supply of gas and adapting it to such a variety of purposes. He could not help thinking he was to be congratulated because he was not under parliamentary regulations. He (Mr. Jones) questioned whether a gas company under parliamentary regulation, or a municipal authority, could do the same with their gas as Mr. Onslow was doing. There was, he felt confident, an unlimited area of usefulness for gas in the directions indicated by Mr. Onslow's work at Woolwich.

Mr. Fenn, of the Gaslight and Coke Company, gave some particulars with regard to the application of high pressure to industrial purposes. Some time ago the proprietors of a factory in Holloway, who took gas for raising steam for a vertical boiler, wrote to the Company saying that, unless they could reduce the price by about 25 per cent., they would have to abandon its use. A blower was put in, which reduced the consumption of gas by about one-half; and they were able to raise 60 lbs. pressure in 55 minutes, instead of 25 lbs. in two hours. Another case was a varnish works, where a pan was fitted up with high-pressure gas; and now in the whole of the factory they were using gas under pressure for making varnish. Instead of sixteen men, seven or eight were required. It was perfectly satisfactory; and the consumption amounted to about 250,000 cubic feet a quarter. At the "Daily Mail" Mr. Goodenough introduced gas under pressure for melting the linotype. They could melt about 60 tons a week with some £2 worth of gas. It was satisfactory, and was likely to be adopted at other newspaper offices. The pressure was produced by a rotary blower on the premises.

Mr. Webber, in reply, said Mr. Goulden very rightly laid stress on the importance of regarding gas as a heating agent mainly—practically exclusively. He (the speaker) was also very much struck in 1900, when he went to the same town that Mr. Goulden had referred to—Dessau, which was the headquarters of one of the most progressive gas companies in existence—to find that they had already disregarded the illuminating power standard of manufacture, and were quite content to work to a calorific standard of somewhere about 5500 calories per cubic metre. But he understood from Mr. Butterfield that this was reduced in Cologne. The question of what calorific standard should be given resolved itself into the matter of flame temperature, which had not been mentioned in the course of the discussion. He, however, referred to it now, because when they spoke of the calorific power of towns gas, they inferred, with regard to the illuminating applications of that gas in the Welsbach burner in all its forms—whether low or high pressure—a certain standard of flame temperature; and it

was found in practice that this standard could be conveniently worked to with a gas of the character that was represented by this calorific standard. That meant in English terms, somewhere about 520 to 540 B.Th.U. per cubic foot. This was the gas which, as he thought, would do everything that was required in the ordinary industrial work of a town. But they must not forget this point—that when they spoke of calorific power, they inferred flame temperature—because a great deal of the work which towns gas could do, no other gas distributed could effect owing to its low flame temperature. Mr. Thwaite's name was familiar in connection with these matters; and he certainly thought some of his early prophecies were more suggestive than perhaps many people imagined at the time. But he did not know he brought the question of Welsbach lighting into these prophecies. It was the Welsbach light—provided the flame temperature was right—which had rendered possible a reduction of the nominal illuminating power of towns gas. Without this system, they would certainly not be able to work with such gas as Mr. Butterfield spoke of, because it was of very little use indeed in flat-flame burners. It would just make darkness visible. Mr. Thwaite claimed that producer gas was of superior uniformity in calorific power to ordinary towns gas; but he (the speaker) could not admit that for a moment, because as a matter of fact if producer gas was made on the spot where it was required the incessant fluctuations in the quality of the gas were among the greatest troubles of the user. It was this which had made the Woolwich authorities rely more and more upon their coal gas supply. Mr. Onslow was in the happy position of being his own sole consumer; and he could practically do what he liked. What he did was therefore, no doubt, a very good guide to what other people would find it advantageous to do. He made just ordinary power coal gas, and used it at high pressure; and he was turning out every one of the producer gas furnaces from Woolwich. The reason of this was largely the uncertainty of producer gas when used for annealing, tempering, and welding of metal, as well as its low flame temperature. Mr. Thwaite mentioned that with recuperation one could get from producer gas the same temperature as from towns gas. Of course, one could; but recuperation was out of the question in workshop practice in this way. He did not touch the subject of regenerator furnaces at all. They used them for heating retorts. Mr. Humphrey in his remarks was speaking with reference to the South Staffordshire Mond Gas Company's business throughout; and he could not discuss that. He (the speaker) was dealing with towns gas. The South Staffordshire Mond Company's plant was the only example in the kingdom—and he thought in the world—in which an attempt was being made to distribute fuel gas for general purposes. It was a special matter altogether, utterly outside the limits of the paper—large as they were. Mr. Hawksley very justly attached extreme importance to a proper pressure in houses. This really was everything. There was no doubt gas companies generally had a lot of leeway to make up with regard to the maintenance of a sufficient pressure constantly. The ideal standard of gas distribution should be the existence in the mains of the same pressure, within a very small margin of difference, night and day. It used to be considered that a low pressure in the mains was conducive to economy; but this idea he was afraid had done incalculable harm, because it was not true. The pressure at which most companies had come to distribute their gas was many times greater than was the case ten or fifteen years ago; but the leakage had practically not increased at all in consequence of that. There was no more difficulty in making a distributory system tight for 20 inches of water than there was for 2. It meant doing away with the old superstition that it was necessary to vastly increase the pressure during the lighting hours, and that for the rest of the time it might take care of itself. There might be only a few consumers who wanted the high pressure now; but what about the others who were coming on? It was of the first importance that everybody should be able to rely on having all the gas that he wanted at the pressure which would do him most good. There was no real difficulty. As to other remarks, a good deal depended upon the way in which houses were carcassed—a term now applied to the putting-in of gas-pipes during building. No doubt there was a tendency to skimp there. But there was no reason for this, because the difference between proper fittings and what would just pass was merely a question of a few pounds' weight of iron barrel, and was not worth consideration. With regard to the alleged dryness of heat from gas-fires, this was an old acquaintance. The impression of dryness was, he believed, mostly due to a slight leakage of the products of combustion into the room, where it was not sufficiently ventilated. Sometimes in the case of a down-draught, or something of that kind, if there was any large escape of gas products into the room, no doubt there was a feeling of dryness. But this was really a question of stove construction. He was afraid that the makers did not provide sufficiently wide canopies for the products of combustion, which sometimes took the line of least resistance and came into the room instead of going up the chimney. But where windows were systematically left open day and night, there was not much reason for complaint of pollution of the air by gas-fires. Mr. Killingworth Hedges had asked as to the duty of gas-fires. This was rather difficult to get at. His impression was that an ordinary modern self-contained gas-fire of good construction would probably radiate 27 or 28 per cent. of the total value of the gas consumed. A paper on this very subject was at that moment being presented to the Institution of Gas Engineers by Mr. J. H. Brearley, who had gone into the matter very carefully. If they could secure more air-warming effect from the black heat after they had done with the radiation from the fire itself, they would materially improve the results attained. When he said that the radiant duty was 27 or 28 per cent., they must not take it that this was the whole of the value. There was, of course, some more heat they got from the warm air passing round the fire. If they could do what Mr. Hedges said—carry the flue up in front before passing it into the chimney—of course, practically the full duty would be obtained; but he never saw that arrangement himself, and he did not think ordinary people would like it, because (however efficient it might be) it must be distinctly ugly. Neither did he see how it was going to stop down-draught. After explaining the principle of the bunsen flame, in connection with remarks as to soot and smell, Mr. Webber referred to Mr. Hedges' contention that there had for many years been no important improvement in gas-fires, and pointed out that there had been a great improvement of late. In the packing of a gas-fire, the fuel was now arranged as a rough kind of chimney; and the flame burned inside that, and did not touch anything at all until it was dead, and then one could pack stuff over it. If an atmospheric flame touched anything while it was still alive, there was an offensive smell and a waste of gas. In reply to Mr. Lowcock, he then explained how at Woolwich the gas was applied for heating metal in a crucible. He said that at certain intervals holes were made in the fire-brick casing; and the burner was just allowed to look in. The flame did not touch the crucible.

Mr. Lowcock said it was almost the same arrangement as he used himself; but possibly he had not a high enough pressure.

Mr. Webber remarked that the pressure of the gas only was raised. The other method had been tried; but it was found dangerous. It was difficult to realize how much dust there was in the air of London and other large places. When one considered that in the working of an incandescent burner about 5½ times the volume of gas was required in air, which was being drawn in with great velocity, and that the air might be heavily loaded with dust, this accounted for a great deal of difficulty.

Sir George Livesey pointed out that walls were blackened just as easily in country houses from hot-water pipes as from anything else. He thought the discussion had been most interesting and instructive.

## GAS DISTRIBUTION AT INCREASED PRESSURE.

By Mr. Charles Carpenter, M.Inst.C.E.

**[A Paper read at the Engineering Conference on June 20.]**

The Companies supplying London with illuminating gas possess in their distributing mains a heritage specially valuable from the fact that it was designed when the supply pressure differed but little from the sending-out pressure, and that it was laid down before "direct labour" had become a municipal fashion, or the thoroughfares were given up to tramways on the conduit system. In those days the leading main from the works supplied the first consumer outside the gates; and the water-seal of his meter was the only factor determining the maximum pressure of his supply—a maximum seldom, if ever, reached. The minimum was fixed by Act of Parliament as long ago as 1847, at the equivalent of 1 inch of water by day, and 8-10ths of an inch after midnight. Of course, nowadays the regulation is a dead-letter; suppliers and supplied having long since come to their own understanding as to what is required, independently of the cast-iron enactments of the Legislature.

For many years the gasholder was regarded as the storage of pressure as well as of volume. But as it increased in size to the standard type evolved by Sir George Livesey, it became less suitable for pressure-giving, by reason of the fact that economy in design had brought about an increasing ratio between the floating weight of iron in the holder and its cubical contents. In order to get over this difficulty, and at the same time to still further utilize the capacity of the distributing mains by increasing the initial pressure upon them, he suggested, about ten years ago, the use of the non-positive type of fan or blower. The first of these used by the South Metropolitan Gas Company was started experimentally in 1897, for the purpose of improving the supply to a rapidly increasing business district over 3 miles distant by a narrow, much-frequented road from the distributing station. The initial pressure on the main supplying this area is increased to 13 inches of water, giving an adequate supply at its extremity, and saving several thousand pounds in the cost of laying the larger main, which would have been required under former conditions.

The whole of the leading mains in the Company's area of supply (about 52 square miles) are now fed by pressure-raising appliances consisting of non-positive blowers—the increased pressure rising to 20 inches of water. They were supplied by the Sturtevant Engineering Company, and have not given the slightest trouble since they were started. About fourteen are in use; the largest having a capacity of 1¼ million cubic feet per hour. Both gas and steam engines are used for driving; the former being more convenient, as they can be fixed regardless of the proximity of a steam-boiler, and are available at a moment's notice.

To engineers accustomed to the distribution of other fluids than gas, even the increased pressure referred to may seem to be small. But if a gas distribution system is judged on its merits as a power distributor from a central source, it will be found to possess greater efficiency than is commonly supposed.

The South Metropolitan Company have in use a network over 1200 miles in length of mains in all sizes from 4 feet downwards. Yet the unaccounted-for gas, in which the leakage is included, is only 4¼ per cent. The volume leakage of coal gas is, of course, much greater than that of denser fluids such as water, when subjected to similar pressure—being approximately inversely proportional to the square root of the density. To put the matter another way, the supply of gas having a specific gravity of 0·372 at a pressure of 12 inches of water, is comparable on a leakage basis with the supply of water under a head of 2090 feet.

Most of the mains in this Company's district are laid with full turned-and-bored joints up to 18 inches in diameter; recessed joints being used in the larger sizes. A 4-foot main, 2½ miles long, has recently been laid between the Deptford and East Greenwich stations; the joints being half turned and bored. Each testing-section was tried for soundness under a head of 5 lbs. pressure per square inch, after which, as a matter of precaution, the open part of the joints was filled with portland cement. A closed barometrical mercury column was used as a pressure-gauge, coupled direct to the main, and read by a vernier to the one-hundredth part of an inch. By this means, error due to variation in the weight of the atmosphere during the period of test was eliminated. The loss of air during the final test of the main was equal to that escaping from an orifice in the pipe $\frac{1}{10}$ inch in diameter under a pressure equal to 9·2 inches of mercury, or about 4½ lbs. per square inch.

*Discussion.*

Mr. A. J. Martin remarked that the paper was a valuable contribution to a very important subject—a subject in which for many years he had taken close interest. It was true that there was a great deal of superstition in connnection with this question of gas pressure; and it was gratifying to note the very low leakage figure which Mr. Carpenter had attained with his increased pressure—the unaccounted-for gas only amounting to something like 4¼ per cent. He had lately been in communication with the General Manager of the Gas and Electric Lighting Company of Aurora (U.S.A.), who was in charge of a lighting district over 50 miles in length, embracing 24 cities and towns. The distribution was carried on at a pressure of 15 lbs. a short time ago; and he was not sure that they had not now got it up to 50 lbs. Knowing how the question of leakage was raised on this side whenever the subject of increased pressure was brought forward, he wrote over to Aurora. The reply was that there had been no trouble during the past winter—in fact, the high pressure distribution was causing them much less trouble than the low pressure. As to leakage, there had been no difficulty whatever. It was hard to foresee all the consequences that would result from the adoption of high pressures. One thing which seemed tolerably certain was that small works producing gas under difficulties, to which coal could only be delivered at a high price, would disappear, and the gas would be supplied by large works like the South Metropolitan, where the advantages as regards transport of coal, &c., were greater. One paragraph in the paper was very significant. The author said, "If a gas distribution system is judged on its merits as a power distributor from a central source, it will be found to possess a greater efficiency than is commonly supposed." He thought this was putting the matter very mildly. In this country, people rather ran away with the idea that everything was going to be done by electricity. They were not so fully alive to what was possible in connection with gas. To put the case briefly, he might say that working on a large scale at high pressures both with gas and electricity, the weight of copper required to carry a given power a given distance electrically was actually greater than the weight of steel needed to carry sufficient gas to give the same power. When they came to heat, the advantage in favour of transmission by gas was overwhelming. If they considered that a ton of copper, at its most favourable price, was six or seven times as dear as steel, and that the insulated cable cost from three to seven times as much as the bare copper, the balance in favour of gas would be obvious. Then again power could be conveyed long distances by means of gas with a loss of (say) 3 per cent., as against 10 per cent. or more with electricity. It would be remembered that the London County Council introduced a Bill, by which they proposed to produce electrical power and transmit it to 29 sub-stations; the amount of current—114,000 kilowatts—averaging 4000 kilowatts to each station. The cost of the cables to convey the current from the generating stations to the sub-stations, and the ducts to carry these cables, was estimated at £666,000. If, instead of electricity, gas were distributed and used in gas-engines, and an equivalent quantity of it was taken to each sub-station, a 4-inch pipe at 60 lbs. pressure would do the work. With a 6-inch pipe, the pressure would be much smaller. The cost of these 4-inch pipes, of the average length of 4 miles per sub-station, would be £43,000, as against the £666,000 for electricity. This was for ordinary lighting gas. At first sight, the use of lighting gas for generating electricity seemed out of the question; but if they looked up the cost of coal to the Electricity Companies in London, it would be seen that they would in many cases obtain their power as cheaply by using the gas of the South Metropolitan Company at its present price. It would be interesting to know the cost at which Mr. Onslow made his gas at Woolwich—gas which he supposed was of the same character as that supplied in London, but made, he took it, without regard to illuminating standards.

Mr. Webber said that he did not know the price. The gas factory at Woolwich was a part of the Royal Arsenal. Of course, it was a small gas-works; and he did not expect the price was very far away from 2s. 6d. per 1000 cubic feet.

Mr. C. E. Jones said he had heard it was about 2s.

Sir George Livesey (the Chairman) remarked that it was about the same as that of the South Metropolitan Company. The Company had been in competition with them; and the authorities found that to take the Company's gas was about as cheap as it would be to make it themselves.

Mr. Martin added that if the Chairman (Sir George Livesey) were given a free hand to supply the gas that was best for the consumers, they would have it at a very much lower price than was charged to-day; and he thought that Parliament and the County Council would do well to give some of the attention now being devoted to the supply of electricity in bulk, to removing some of the restrictions which prevented a gas company from supplying gas of high calorific power at a low price.

Mr. W. J. Dibdin, after congratulating Mr. Carpenter on his paper, remarked that the question of high pressure supply of gas was not a new one to him by any means, because it was perfectly obvious that anyone who had to use gas for heating purposes in a laboratory must realize at a very early age that it was a great pity that they could not get a higher pressure. He had been wondering why it had not been done before. He had mentioned the matter more than twenty-five years ago to gas engineers, but had always been told that the difficulty of loss by leakage was insuperable. He was glad to hear that it was now an established fact that there was no reason why gas should not be supplied at a higher pressure; and he would look forward to a very considerable development of the gas industry therefrom. Those who had had to do with the old charcoal furnaces knew the advantages of gas; and when they went from low pressure to high pressure, the gain was very great.

Mr. T. S. Lacey said that the limits within which the paper had been confined had necessarily made the interpretation of the title somewhat difficult. In the case of the distribution of gas in London, owing to the great distances to be covered, the system in use in smaller towns, of immediate distribution from the station without any increased pressure, had for a long time become impracticable—so much so, that at Beckton it was found from the first that the holders did not give sufficient pressure to supply consumers in London. The whole of the gas made at the Beckton works had to be pumped. This would amount to more than 50 per cent. of the make; and in winter was 60 million cubic feet per day. The gas was pumped to a maximum pressure of 48 inches of water at Beckton. Necessarily, this was reduced on the high-pressure mains which went from one end of London to the other, and took up the different stations on the way; so that the gas would ultimately go 10 or 12 miles to Fulham. There were two 48-inch mains from Beckton, one of which went through the North of London, and the other he believed along the Embankment. From these high-pressure mains, they could take gas into the holders. The pressure was sufficient to lift the holders; but if they wanted to get the gas back into the high-pressure mains, obviously they must pump it. At all the stations, therefore, connected with the high-pressure system there were pumps, so that they could either take gas out of the 48-inch main or put it back again. From any one of the stations they could supply a district through suitable governors. The first case to which Mr. Carpenter alluded was the necessity of increasing the pressure of the holders to supply a district; and he stated that the initial pressure was 13 inches. In another case, 20 inches was mentioned in the paper; but he took it that there were no consumers who would come on at 20 or 13 inches, but that the pressure would at some point be reduced by a governor, and the gas introduced into another part of the district. This was a case in which it was very obvious that an increase of pressure might lead to considerable economy, as it avoided the laying down of unnecessary mains. But there was another point in regard to this increase of pressure which had probably been in the minds of a great many gas engineers. They knew as a fact that the efficiency of the Welsbach burner was very much increased by what was really after all a very slight increase in the pressure of the gas—that was to say, if a Welsbach burner at a pressure of 1½ inches gave an efficiency of 20 candles, it would perhaps only be necessary to increase the pressure to 7 or 8 inches in order to get an efficiency of (say) 30 candles. The pressure they kept up in their district was frequently 4 or 5 inches; and an increase from (say) 5 to 9 inches was so paltry, and so immaterial, that some people might say, "Why do you not do it at once?" Then there arose a number of questions which one had to consider. It was not after all so simple. If they could maintain a constant pressure, he did not think (though he was not a distributing engineer) there would be any danger in working the pressure up to 6 or 9 inches. The most dangerous thing was to reduce the pressure; but if they maintained the pressure to every consumer at the same figure—say, 6, 9, or 12 inches—when a man turned down the tap of his fire, for instance, the gas would keep at the particular pressure at which he required it. It would not do at all to have a pressure that sometimes perhaps was 9 or 10 inches

and at others went down to (say) 2 inches. As he had said, if they could increase the pressure, they would raise the efficiency of the incandescent lights, for which he believed 9 inches was ample—at any rate, an infinitely better light could be obtained by increasing the pressure a very few inches. This was a point of great importance; but how far they could increase the pressure, and how they should deal with the difficulty of keeping the pressure constant, were questions for the distributing engineer. He thought the author might tell them how he proposed to deal with them. An increase of the pressure in the leading mains obviated the laying of new trunk mains; but a more important thing to his mind was the increase of the pressure to the district itself, which was an entirely different matter, and affected the manner in which the gas was burnt.

Mr. A. C. Auden said that, as representing the consumers, the particular thing he should like to speak about was the question of raising the pressure of gas on the premises. His practice was confined almost entirely to the building and equipment of factories; and a little while ago he put in an installation for increasing the pressure of gas for lighting purposes. He put in a booster; and certainly the lighting effects and the economy were magnificent. He had never lighted a large factory at anything like the figure. They increased the pressure up to from 10 to 12 inches. They tried it higher, but found that 10 inches was a good working point. There was, however, one very great disadvantage. The factory in question was a large printing works, and the stereo and type metal had to be melted, and kept melted at a definite temperature practically the whole day long; and they could not get this properly done with the high pressure. The metal could not be kept at the right temperature. Various burners and all sorts of things were tried; and then he put in alternate burners on two rings, and used both rings for boiling and one for keeping the metal at the right temperature. The metal, however, was badly affected by the intense heat at different points. He would like to know where he was wrong. As it was, he had simply had to put another pipe in from the main; and the stereotyping pots were working with the ordinary pressure, and were doing all right.

Mr. J. L. Chapman said that as the efforts he had made to give a full pressure had resulted very satisfactorily, he would like to relate—especially with reference to keeping even pressures—what he had found to work well in a country district. At one time, the Harrow and Stanmore Gas Company had two works; but eventually the smaller of them was closed down. The gasholder, however, which was 6 miles from the present works, was left. They worked with a pressure of some 3 inches in the day-time; and since they had done so, the increase in the business of the Company had been wonderful. There was a 12½ per cent. increase in the past quarter; and there looked like being a 20 per cent. one this quarter. This, he believed, was greatly due to the care he took that no cooking-stove or fire ever suffered from want of pressure. With Mr. Carpenter, he had found no increase of leakage. There was a large leakage, because the Company had something like 60 miles of mains, with a very small proportion of consumers. What they did was to let the gas work into the holder at the end of the district, like a balance governor. It had fixed stops; and they could so work it, at this distance away, that during the hours of cooking it would go down. It was a single-lift holder, giving from 28-10ths to 30-10ths pressure; and by going down when the cooking was being done, it kept the pressure through the whole district even, so that there was no sudden change. At night-time the holder supplied the end of the district in which it was situated; and without it they would have to enlarge the mains to get a satisfactory supply of gas. He thought in many cases where engineers had wide districts the method he had explained would be found to work satisfactorily. He did hold with Mr. Carpenter that, if they were going to increase their consumption and keep their customers pleased, the great thing was to maintain a constant high pressure of somewhere about 25-10ths to 30-10ths, even in the daytime.

Mr. William King remarked that the cost of distributing mains formed a very large proportion of the capital of a gas company; and therefore any device by which the small and older mains could be made available to meet new circumstances, and the increased pressures required under modern conditions, could not fail to be interesting to those concerned in gas supply. He was brought face to face with this problem in 1878 in the case of Liverpool. Their outlying works had, as at Beckton, an independent main carrying a supply of gas to holders situated in the midst of the consumers. The main for years was sufficient; but as the consumption increased, the problem became how to meet the demand and get the gas quickly enough where it was wanted. The question was, Should they increase the size of the main or the initial pressure? The gasholders were insufficient for the purpose; and, after much thought, he determined to increase the pressure rather than go to the expense and trouble of ripping up miles of street, which vexed the public and caused inconvenience generally. It was therefore determined to put up pumping machinery at these distant works. That was in 1878; and by this means the nuisance and the expense to which he had referred were avoided. The pressure, of course, at first was little in advance of the gasholder pressure; but by degrees it was increased, until the initial pressure was 40 or 45 inches. They used Beale's exhausters, with engines attached, working directly. This system had worked, he believed, to the present moment very satisfactorily. With regard to the pipes, Mr. Carpenter had given some details. He might say that in the case of the whole of the pipes at Liverpool, there were entirely bored and turned joints. He believed his father was the inventor of the bored and turned joint. At all events, looking through some very old papers he came across an offer by a firm to supply, to his father's drawing, 8 or 10 inch bored and turned joints; and from that time to this they had been used in Liverpool, without a leaking joint being found. He had not had any knowledge of larger than 36-inch bored and turned joints; and he noticed in the paper that the joints were half bored and turned for the 48-inch main. He would like to know the author's opinion of the turned and bored method; for he believed that of late years, with the South Metropolitan Company, the system had been largely adopted.

Sir George Livesey: I took it from you years ago.

Mr. King remarked that he could say up to 36 inches entirely turned and bored joints were satisfactory; and no increase of leakage occurred with the raising of the pressure to 40 inches.

Mr. E. R. Dolby, speaking as a consumer, said it seemed to him care should be taken in increasing the pressure in the mains which supplied ordinary consumers. He would just mention one small accident as an example. One Saturday some time ago, he noticed a good many balloons rising one after another in his district. On the Sunday morning about 7 o'clock, there was a terrific explosion at a house not far from his, by which two people were severely injured. He examined the place; and there was a hole 3 feet in diameter through the ceiling of the front sitting-room. A neighbour of his told him that he had returned home about midnight, and found some water upon the top of his table, and a very strong smell of gas. That came from a pendant—a water-slide arrangement, of course. What had happened in the house where the explosion occurred was this: The couple sleeping in the room over the sitting-room smelt gas and went down. They had no light, but as soon as they opened the door there was an explosion. They had forgotten a bye-pass was alight in the hall. He did not know personally whether this accident had any connection with the charging of the balloons; but he did suggest that if the pressures were to be increased suddenly upon the consumers, they ought to be warned that these water-slide fittings should never be used.

Mr. F. L. Wilder, an electrical engineer, said that the idea of bringing gas in high-pressure mains to holders, seemed exactly like that of bringing high-pressure electricity to various substations in a town; and therefore they might learn a good deal from the example and practice of electrical engineers. There were great advantages. The very big mains might reasonably be reduced to a large extent; the governing of the pressure to what was required by a system of low-pressure mains for actual distribution, would be done by holders placed in convenient positions (much smaller, perhaps, than were now necessary); and a great deal of advantage would be gained by the smell—he was speaking of small towns—being reduced near the town, as the gas-works might then be taken any convenient distance away, and simply the holders used in different parts as substations. One could see what the effect in electrical working had been of raising the pressure; and very possibly the same results would occur in gas working.

Sir George Livesey said that before calling on Mr. Carpenter for his reply, he would remark that the papers and discussions had been very interesting. There was a connection between Mr. Carpenter's and Mr. Webber's contributions; and the moral was that the higher the pressure at which gas could be supplied, within limits, the greater the effect that could be produced, with stoves and with incandescent lighting. Mr. Carpenter dealt with one-half of the question of the high-pressure distribution, and showed what had been done in the case of the South Metropolitan Company. Ten years ago, there was an urgent necessity to increase the trunk mains leading out from the works. He (Sir George) did not like the expense, and particularly the trouble and difficulty of altering the mains; and so they adopted the principle described by Mr. Carpenter. They had not laid a large main since, though business had much increased. There had also been another effect. They had there four large gasholders, the united capacity of which was 30 million cubic feet; and of this 10 million cubic feet was quite useless for supplying the area, because the pressure in the upper lift was too light to give the proper pressure in the district. A result of the adoption of the blowers and fans had been to render effective this 10 million cubic feet of gasholder capacity. The other half of the question was this: He had had many dreams, and some had come true; but whether this would, he did not know—that the high-pressure distribution should go to the consumer. The first attempt they made was in connection with Clapham Junction, where the Company had always had a difficulty in keeping up a sufficient supply of gas; but they happened to have an 18-inch main from the gasholder station at Kennington, independent almost all the way. They tried an extra pressure on this main; and it had settled the question until now. They isolated and made the trunk mains independent by taking off all the side supplies, and delivered the gas at a high pressure a considerable distance from the works. But this was all they were doing. The other point was whether they could not increase the pressure all over their district, to all the consumers, so that they could get a sufficient supply of gas for all purposes, such as had been referred to by different speakers. And then came Mr. Dolby's objection. The most dangerous thing connected with gas supply was these water-slide chandeliers;

and Mr. Carpenter a few months ago had made a suggestion to the Board that the Company should undertake the alteration of all the water-slide fittings in their district, to make them safe. The Company could not give an intimation of this kind to all the consumers, because it would take time; but they were doing the work district by district. There were a good many thousands of such chandeliers; and they were a source of danger. Of course, it would never do to increase pressures to any great extent while numbers of these fittings remained in use. Then, again, there were the meters, which were not quite adapted for high pressures —especially the wet ones. But they should remember what had been done in connection with natural gas in the United States, where enormous pressures were introduced. There a reducing governor was put into the houses; and that could be done here. The dream he had was that some day high-pressure gas would be supplied all over their towns and districts, and consumers would have gas at whatever pressure they needed for their purposes. It was a curious thing, but the time pressure was most wanted was between 11 and 1 o'clock on Sunday, for cooking purposes.

Mr. Carpenter, in reply, said there were one or two points Sir George Livesey had not touched upon; and he would refer to these. Mr. William King spoke about the 48-inch main having half turned and bored joints. This style was adopted merely as a precaution. The main was tight at 4½ lbs. per square inch pressure. Mr. Lacey spoke about the distribution of gas at a higher pressure. He (the speaker) did not think it was possible to keep a uniform pressure in all one's mains throughout the 24 hours; but what they could do—and he thought it would be found much the more economical way—was to distribute at a higher pressure than was wanted, and govern it down by means of a consumer's governor, in the way suggested by Sir George Livesey. This would ensure the consumer getting a constant pressure throughout the whole of the 24 hours. In considering pressure in the mains, the different levels of a district were a disturbing factor; but a consumer's governor would regulate it—there being, of course, always an excess pressure in the mains. This was one of the advantages the distribution of gas had over electricity. The governor which would give the consumers a constant pressure throughout the whole day was a very simple appliance; but the apparatus that would similarly regulate electricity would be a most complicated piece of mechanism. As to other remarks made, there was a text-book used when he was a boy in which there were three "Golden Rules." One of them was "Keep down the Pressure in the Mains in the Daytime." It was only lately that gas companies had come to realize the importance of keeping up their pressure throughout the whole of the 24 hours. With regard to maintaining a uniform pressure and the ability to get from the pressure a uniform temperature, the chicken incubator might be cited. The most successful system was one in which the temperature was regulated by a gas-flame. They were all much indebted to Mr. Martin for his remarks in reference to gas-works as distributors of power. The amount of gas his Company sent out per hour, if used in engines, would be equal to about 500,000 horse power. This was their maximum figure in South London. Mr. Martin put the case so clearly for the distribution of power from central works to sub-stations, that he could only endorse his remarks. He should not think there would be any necessity for raising the price of gas a fraction to the consumer for a higher pressure. In his remarks, of course, he had been referring to lighting gas, not producer gas.

## Further Increase in the Price of Gas in London.

In a circular-letter sent out last Saturday by the Secretary of the Gaslight and Coke Company (Mr. H. Rayner), the Directors express regret at having to announce that the price of gas supplied to private consumers in the Company's district south of the Thames will be increased, as from the date of recording the meter indices for the quarter ending at Midsummer, from 2s. 2d. to 2s. 5d. per 1000 cubic feet; and that on and after the 1st prox. the price of gas supplied by the Company to all public lamps, both north and south of the river, will be similarly increased from 2s. 2d. to 2s. 5d. per 1000 cubic feet. It is explained that the Company's price south of the Thames is, by statute, regulated by that of the South Metropolitan Gas Company; and the increase in the case of the Gaslight and Coke Company therefore follows automatically that of the first-named Company, and is, moreover, rendered necessary by the seriously increased cost of coal and oil.

The death occurred last Thursday, after only three days' illness, of Mr. Perry Fairfax Nursey, the Secretary of the Society of Engineers. Deceased had been connected with the Society practically from its foundation in 1854, and had contributed very largely to its "Transactions." One of his papers, on "Recent Practice in Cane-Sugar Machinery," appeared in the volume for the past session noticed last week. On the occasion of the Society's Jubilee, he wrote an interesting account of the origin and progress of the organization. He was President in 1886, and twice held the office of Secretary. Mr. Nursey's genial manner gained for him many friends; and he will be greatly missed at the gatherings of the members of the Society with which he had been so long identified. It is only just to his memory to record that in discharging his secretarial duties we invariably found him courteous and obliging. He was in his 77th year.

## THE NEW COKE.

By H. Leicester Greville, F.I.C., F.C.S., &c.

Surely the above is a better term for the material which is designated "Coalite." After a prolonged period of what the average journalist would call "anxious suspense," we have at last a full prospectus issued, which I have carefully perused.

I am glad to see that the Gaslight and Coke Company have "taken the bull by the horns," and practically demonstrated the possibility of producing a smokeless fuel having certain advantages over ordinary gas coke for purposes of domestic use. Whether there will be a sufficient public demand for a special smokeless fuel similar to, if not identical in its characteristics with, "Coalite," remains to be seen; but there is no doubt that ordinary hard gas coke is not universally appreciated as a fuel for domestic purposes. I am not altogether surprised at this. In the first place, coke as delivered is seldom obtainable at less than £1 per ton (wet or dry); and coke can hold a very large quantity of water. With coal at normal prices, "hard cobbles" can be bought at the same figure, or even cheaper.

My experience, even with broken coke, has been this: It cannot be ignited with a small proportion of wood, like coal; you cannot keep a small fire going in an ordinary grate; a fire neglected for even a comparatively brief interval goes out; and the amount of ash is excessive, and a constant source of complaint from the servant or housewife. The alternative of gas, as a smokeless fuel, is unrivalled for cooking, as well as for judicious use in gas-fires for warming rooms for limited intervals; but it is, I think, costly if used throughout the day as a substitute for the ordinary fire. A sample of "Coalite" has recently come into my hands, and a neighbour is pleased with its general behaviour as a fuel. On inspecting the small fragment I had, it was obviously coke produced at a comparatively low temperature.

I notice a phrase that you use in your editorial article on "The Smoke Nuisance," in the current issue of the "Journal." "Smokeless fuel or incompletely carbonized coal—such as Coalite." Is "Coalite" "incompletely carbonized coal?" I much doubt it. I should say that it was low-temperature coke. Of course, there may be two methods of producing from the carbonization of coal a residual which would be more combustible than ordinary gas coke. One method would be drawing the charge before all the gas was exhausted, which would seem to be wasteful; the other, complete carbonization at a lower temperature, with the recovery of the whole of the gas and the bye-products. What would be the effect of the latter course of action? A larger proportion of an easily combustible coke, a smaller volume of gas of higher illuminating power with lower sulphur compounds, and an increased yield of tar and ammonia—the former being more fluid and of a different character from ordinary gas tar. It would presumably contain less anthracene, and the volatile portions would, no doubt, have the paraffin series of hydrocarbons preponderating over the benzene series.

There is no doubt whatever that any ordinary gas-works could operate on any lines with regard to the temperature of carbonization, and turn out a practical "Coalite." How would the new conditions of carbonizing work? Of course, they would only apply to a limited amount of the total coal carbonized, the bulk of which would be dealt with in the ordinary way. The disadvantage would be a material loss of gas made per ton of coal; the advantages, more coke of possibly greater market value for special and limited purposes, a larger yield of ammonia and tar, and gas of higher illuminating power.

The whole question is worthy of serious consideration. There is, however, one aspect of the case which has occurred to me, and which (as simply a suggestion) may possibly prove worthy of some little thought. A process of gas manufacture has been recently introduced in which the gasification of tar has been successfully accomplished. I allude to the so-called "methane-hydrogen gas," with the process for making which most of your readers are well acquainted. Briefly, tar is gasified or vaporized, and the vapour, with steam, passes through the usual columns of incandescent coke, with the production of a modified water gas. The advantages claimed—and I believe the process is a practical success—are that tar and coke, both products of gas-works, can be utilized to produce a gas of a higher general value than ordinary water gas.

Now, supposing that gas-works were making a certain amount of the "new coke," why should not the increased proportion of tar be used in an apparatus on the lines of that used in the methane-hydrogen process, with corresponding increase in the value of the gas? Then, further, the richer gas produced from the carbonization of the coal at a lower temperature would afford a source of enrichment in raising the illuminating power of the water gas, and thus effect a saving over the amount of oil used for the ordinary carburetted water gas.

Perhaps the last word has not been said on the possibilities of seriously considering what could be accomplished in the manufacture of the "new coke." "*Experientia docet*," and some considerable time must elapse before the question can be settled.

Mr. Francis Faulkner Brown, a Director of the Chester Water Company, left £103,504. Sir Benjamin Baker left estate valued at £170,513 gross, with net personalty amounting to £166,513.

# GERMAN ASSOCIATION OF GAS AND WATER ENGINEERS.

## FORTY-SEVENTH ANNUAL MEETING.—MANNHEIM, June 11 to 15, 1907.

## REVIEW OF THE PROCEEDINGS (Continued from Page 811).

[From Our Own Correspondent.]

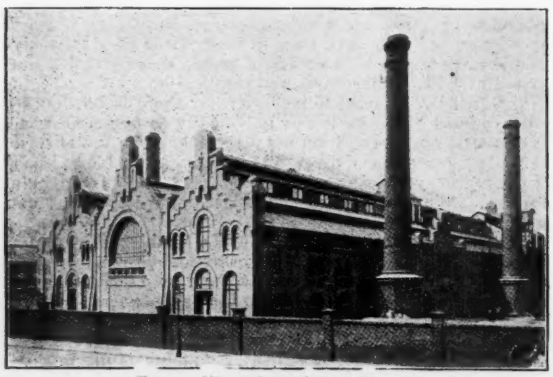

Fig. 1.—View of the Retort-House.

The particulars given last week of the interesting installation of vertical retorts on the Bueb or Dessau system at the Ehrenfeld gas-works of the Cologne Municipality, were somewhat meagre. The following further particulars, derived partly from the paper which Herr Prenger, the Manager of the Cologne gas and electricity works, read before the meeting, and partly from personal observations on a visit to the works last week, will therefore be of some interest.

The City of Cologne is rapidly growing in size; and the amount of gas delivered from the works shows increases year by year of about 8 per cent. on an average. Such a rate of increase (compound) necessitates frequent extension of the manufacturing plant; and at the present time the Ehrenfeld works are being enlarged in all directions. Incidentally, some of the new plant, besides the vertical retorts, may be referred to in the sequel. The vertical retort-house (fig. 1) comprises two spans side by side, 67 metres (= 220 feet) long by 11½ metres (= 37¾ feet) wide. Under each span are two blocks of settings, placed end to end, each block containing six settings of ten vertical retorts apiece. Last week only one of the four blocks was in action, and that one had only been working for about ten days. Another block was being warmed up ready for working shortly. Each block is intended to have a productive capacity of about 25,000 cubic metres (= 880,000 cubic feet) per diem. The retorts are 4 metres (= 13·1 feet) in length, and each receives a charge of from 500 to 550 kilos. (= 1100 to 1210 lbs.) of Westphalian coal. The working off of this charge occupies 10 to 12 hours; during the last two or three hours steam is passed into the retort with a view to the formation of water gas by interaction with the incandescent coke then in the retort (fig. 8). The admission of steam is regulated so that the average gross calorific power of the mixed gas shall not be below 5000 calories per cubic metre (= 562 B.Th.U. per cubic foot). Actually the calorific power of the gas made averaged about 5250 calories per cubic metre (= 590 B.Th.U. per cubic foot) gross, or 4900 calories (= 550 B.Th.U. per cubic foot) net. One producer serves a setting of 10 retorts (fig. 9). Each setting has a separate hydraulic main, to which the gas passes by horizontal

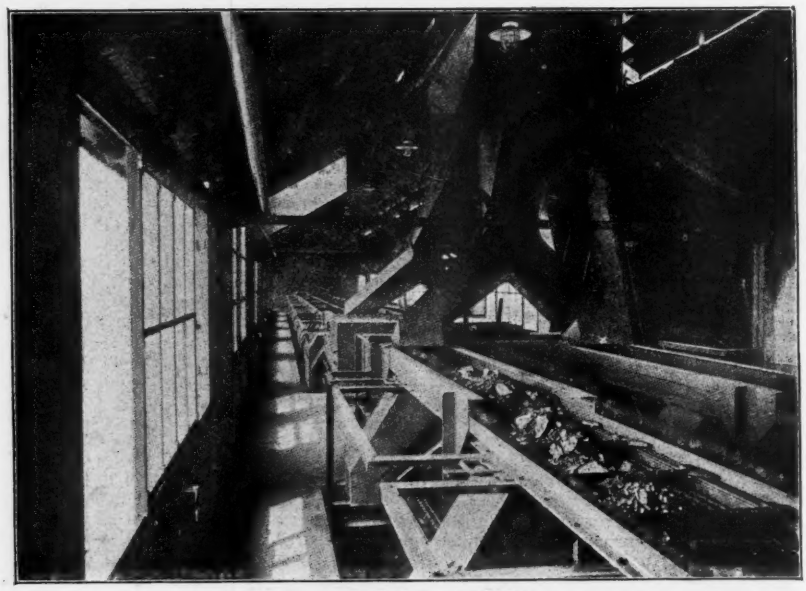

Fig. 2.—Coal-Conveying Plant.

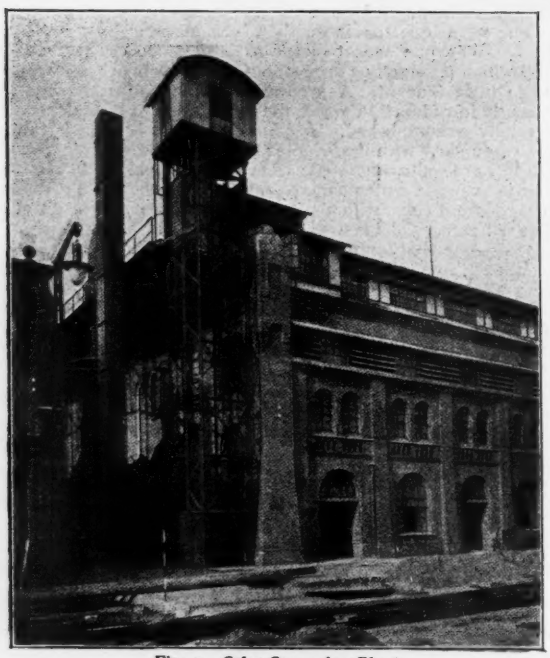

Fig. 3.—Coke-Conveying Plant.

outlet-pipes from the upper mouthpieces of the retorts (figs. 6 and 7). A vacuum of from 15 to 20 mm. (= 6 to 8 tenths) is maintained on the hydraulic, with very slight fluctuation. A little water is run into the hydraulic continuously. The tar is highly fluid as compared with ordinary coal tar. The heats of the settings were very uniform, as judged by observation through the sight-holes at three levels in the face of the setting. The temperatures were reported to average at the lowest part of the setting 1350° C. (= 2462 Fahr.); in the middle, 1250° C. (= 2282° Fahr.); at the upper part, 1050° to 1100° C. (= 1967° Fahr.).

On the top of the bench and above the gas-exit pipes is the charging stage; and in the front of it the upper mouthpieces of the retorts protrude slightly above the stage level. At the back are the producer lids (fig. 4). The heat on this stage was not greater than on the stage of a carburetted water-gas plant, and much less trying than on the charging stage of inclined retort settings. A travelling hopper suspended from an overhead line passes along the lines of retort mouthpieces, and receives from overhead coke and coal storage chambers, ranged side by side through the length of the house, either small coke or coal (figs. 2 and 5). The hopper has a shoot, with a spreader, which drops into the mouth of the retort. A little small coke is first introduced, to cover the lower lid and fill the lower mouthpiece; and then the retort is filled with coal to within a short distance of the top. The hopper is pushed away, and the lid closed. Needless to say, the operation of charging is very rapidly and easily performed. The discharging is equally simple. The upper lid is opened, and the gas in the retort and exit pipe lighted to avoid explosive combustion. The lower lid is opened, and the coke falls out cleanly and in a moment. The carbonized charge, when viewed from above, before the lower lid is opened, is a solid core with an annular space in it about an inch wide, between it and the retort walls. The coke as it falls out when the lower lid is opened is received in a funnel-shaped travelling hopper, the open lower end of which stands

over an opening in the conduit in the bottom of which is a conveying trough (fig. 8). A few lumps of coke occasionally escaped the funnel and scattered on the floor, and it would seem that the funnel should be a little wider. On the whole, however, the arrangements for receiving and quenching the discharged coke worked well. It must be remembered that the whole contents of the retort fall out into the funnel immediately the retort-lid is removed, and then more gradually but quickly fall through to the conduit. This conduit is covered by removable iron plates, of which only the one beneath the funnel through which a retort is being discharged is removed at any one time. One end of the conduit is connected with an upcast shaft, which draws off the steam generated by the quenching of the coke in the conveying trough, and carries it into the outer air. This shaft is seen in fig. 3. The arrangement appeared to work very nicely; and the atmospheric conditions in the retort-house remained all that could be desired. Two attendants only are required in the retort-house—one on the upper stage to charge, and one on the lower stage to discharge, the retorts. The time required to discharge and re-charge a retort does not average more than one minute. The conveying trough takes the coke to a pit, from which a bucket elevator and conveyor carry it to the breaking, sorting, and loading apparatus (fig. 3). The coke —bearing in mind that it was from Westphalian coal—seemed of very good quality; somewhat fragile and porous, but with a metallic ring, and apparently completely carbonized. Moreover, when the retorts were opened for discharging, carbonization seemed to be perfectly complete, and there was an absence of any tar or pitch at both mouthpieces. The producers were charged at intervals—so that the fuel bed was kept high—through the mouth on the charging stage level, from a travelling coke hopper (fig. 4, right side).

Broadly speaking, the installation gave a very favourable impression; and there was no question as to the ease of operating and general convenience of the plant. In details, slight improvements are wanted; but the whole arrangements were good and very well carried out by the constructing engineers. In one or two respects, however, commendation must still be guarded. As yet, it has not been possible to pass the gas from the vertical retorts at Cologne through a separate meter; and consequently the yield of gas per ton of coal and per retort is not known. Moreover, the capital outlay has not yet been determined, for the installation is still incomplete. The tendency to extravagance in equipment which was referred to in last week's "JOURNAL" as conspicuous in many municipal gas-works in Germany is, however, not visible at Cologne; for, though all requisite machinery is being installed, there does not appear to be anything superfluous or unsuitable. This is no doubt due to the excellent judgment and ability of Herr Prenger, which is displayed also in many other sections of the new plant at the Ehrenfeld works. The main reason why it is necessary to suspend judgment on the vertical retort installation there, is that it is still quite new. In twelve months' time, worked under Herr Prenger's careful supervision, the plant should have proved its position in relation to the earlier and contemporary modes of carbonizing coal for gas making. Until then, it would be premature, from observation of this one installation, to say that the Dessau system of vertical retorts is all that could be desired. But it is most decidedly of a prepossessing character.

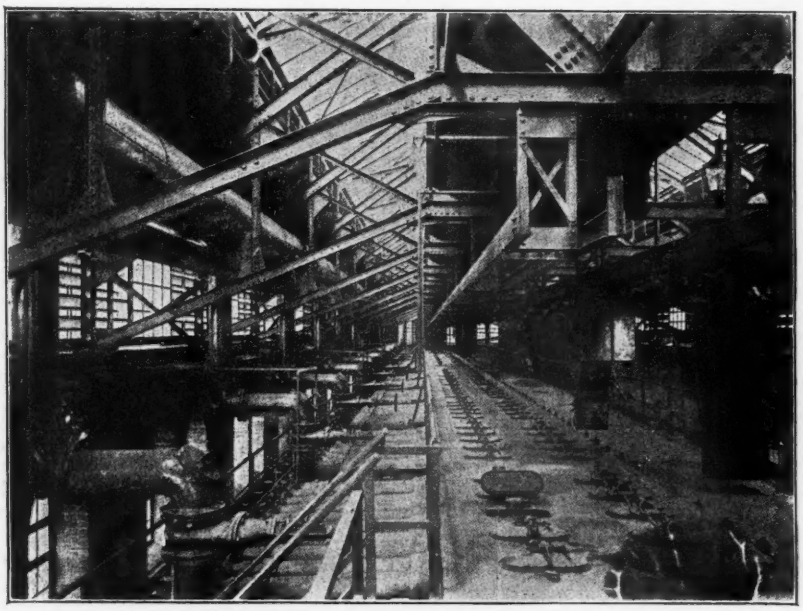

Fig. 4.—Charging Stage on Top of Settings.

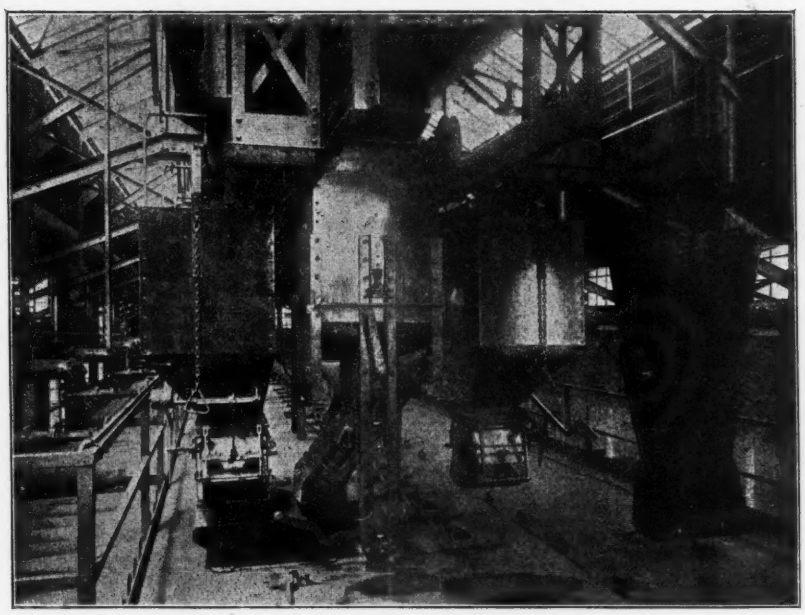

Fig. 5.—Charging Hoppers.

In regard to the other new plant now in course of erection at the Ehrenfeld works at Cologne, it will suffice to mention a few of the more important items. The most conspicuous, and perhaps most pleasing, of the new buildings is a coal-store, adapted for the storage of some 40,000 tons of coal (fig. 10). It is brick built, with a single-span roof, and it is traversed longitudinally by three elevated railway tracks, in communication with viaducts over which the coal is taken across the works. Ultimately the works are intended to comprise three sections, each having a capacity of 2,100,000 cubic feet per diem. There is a water-gas plant, of which two out of four sets are already completed, with a productive capacity of 875,000 cubic feet per set per diem. This plant is adapted for carburetting water gas either by the gasification of oil, or by the vaporization of benzol. A new exhauster-house is to contain seven exhausters (only some of which are in position), of which five are for coal gas, and two for water gas. The new purifying-house contains twelve vessels, of which four are for water gas and the remainder for coal gas. Each vessel is 41 ft. by 26½ ft., and is divided into eight sections, with faced lids with rubber joints. A bridge crane, to lift 2½ tons, traverses the purifier-house, for the purpose of removing the lids of the vessels. The oxide is raised by elevators to the vessels, and distributed by conveyors. The ground floor, on to which the spent oxide is discharged through openings in the bottoms of the vessels, is used as a revivifying area. A diagrammatic indicator, in connection with the valves, shows at a glance the order in which the vessels are being worked. A new condenser-house contains eight vertical atmospheric condensers. In other new houses are three Pelouze and Audouin tar-extractors, Gareis governors, and station meters.

Practically all the apparatus about the works, including the elevators, &c., for the vertical retort-settings, is driven by electric motors. The power required is partly obtained from two new dynamos, of 500 and 300 H.P., driven by Parsons' steam-turbines, and supplied by Messrs. Brown, Boveri, et Cie., of Mannheim. A curious feature to English gas men is the partial use of brown coal briquettes as boiler fuel. The demand for breeze and coke in Cologne is so great that sufficient breeze is not available for firing the boilers entirely with it; and the small "Union" briquettes are used to make up for the deficiency o breeze. The proportion of water gas in the mixed gas supplied from the works is about 25 per cent. Imported petroleum is largely used for the water-gas manufacture; the import duty being reduced to 3 marks per 100 kilos (about £1 16s. 6d. per ton) on petroleum so used. It is only, however, large gas-works such as those at Cologne and Hamburg for which sufficient oil is bought to make it worth while observing the regulations under which the reduced import duty becomes payable. The smaller works usually buy only the German paraffin (brown coal tar) oils, or imported oils on which the full import duty (on more than double the above scale) has been paid. It is on this account chiefly that carburetted water gas is made in few German gas-works.

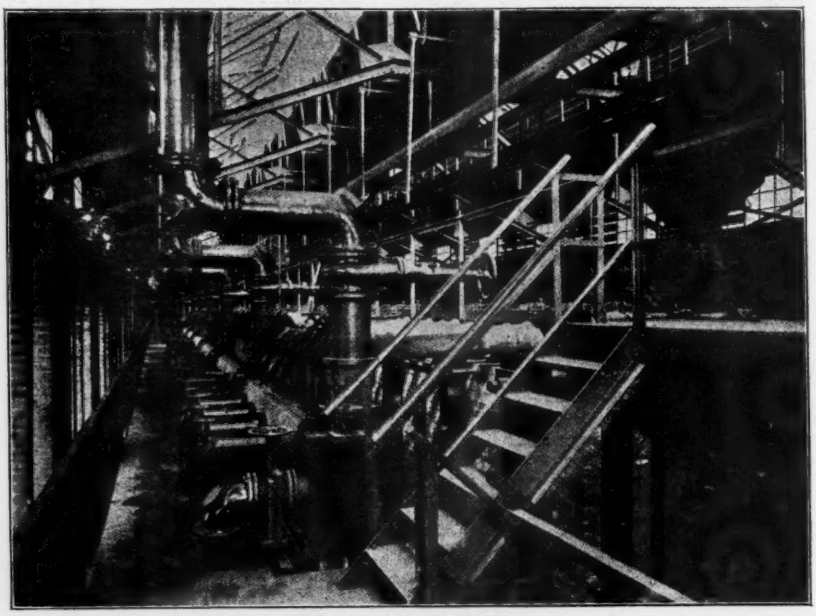

Fig. 6.—Hydraulic Mains.

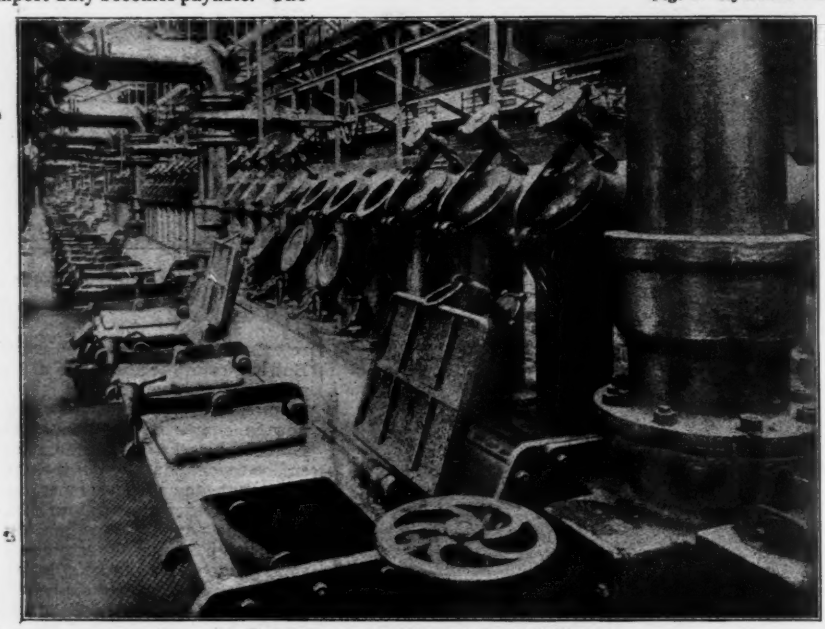

Fig. 7.—Hydraulic Mains and Gas-Exit Pipes.

The extensions at the Ehrenfeld works at Cologne should be completed in the course of the next two years, and then the works would well repay close inspection, as the new plant is being admirably planned by Herr Prenger. It is rumoured that the German Association of Gas and Water Engineers will choose Cologne for their annual meeting in 1909 or 1910, in order to give the members a favourable opportunity of seeing the Ehrenfeld works.

Reverting to the matter of oil for gas-making in Germany, mention was made last week of the paper on the "Supply of Germany with Carburetting Oils," which was read on Friday, the 14th inst., by Dr. Schütte, the Manager of the Bremen Gas-Works. He stated that there were now about 50 water-gas plants in German gas-works—a comparatively small proportion. He referred

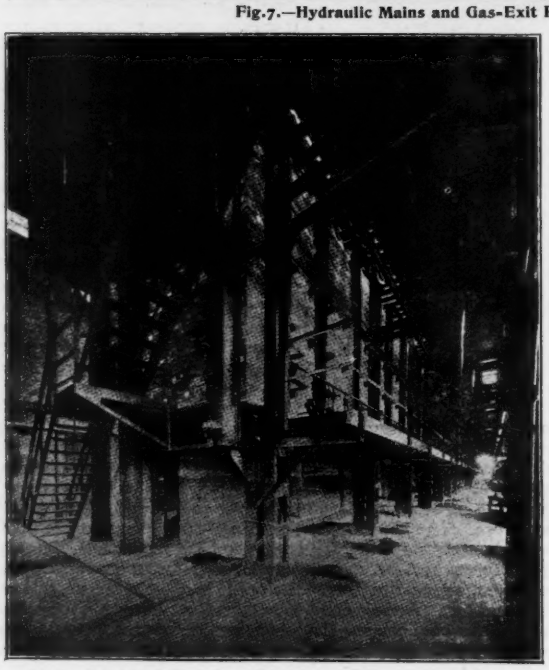

Fig. 8.—Discharging Side of Bench, with Steam-Supply Pipes.

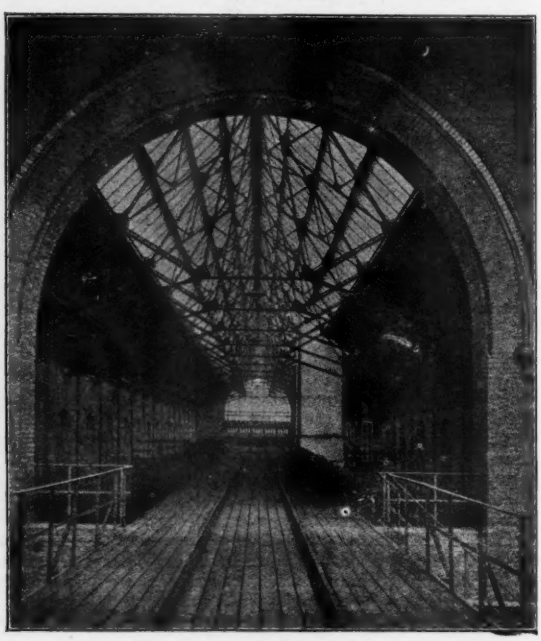

Fig. 10.—View in the Coal Shed.

to statistics, and sought to show that it would be a great advantage to the gas industry in Germany if oils for carburetting purposes were admitted into the country duty free. He suggested that the Association should address a memorial to the Reichstag and Bundesrat, praying for the admission of gas oils into Germany duty free. The meeting decided, after discussion, to authorize the Council of the Association to undertake a new inquiry into the question of the supply of gas-works with carburetting oils, and to take appropriate steps to secure as cheap a supply as possible.

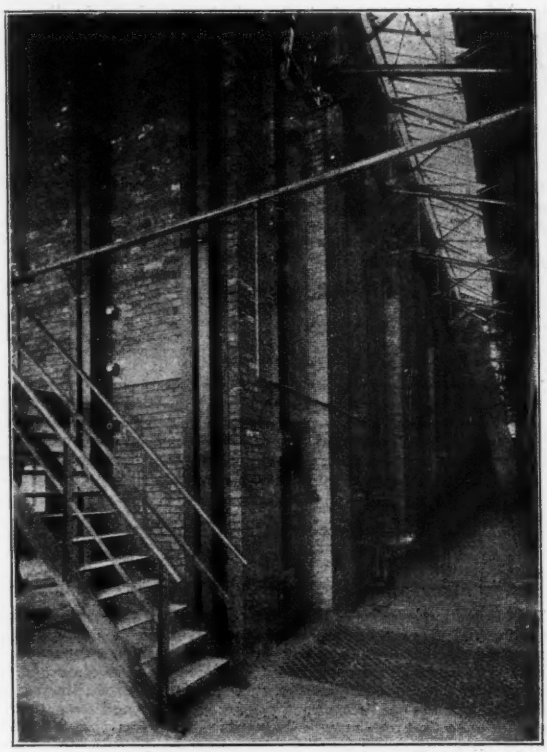

Fig. 9.—Producer Side of Bench.

Of the other papers read on the Friday, that by Herr Kobbert, of Königsberg, dealing with "Questions as to the Limitations of Gas Supply, and their Solution," roused a good deal of interest, and provoked some amusement.

The lecture which Dr. H. Bunte, Professor at the Technical College at Carlsruhe, delivered on the same day, was unfortunately considerably curtailed owing to lack of time. Its subject was the "Combustion Phenomena of the Inverted Gas-Burner." In the course of the brief discussion which followed Dr. Bunte's interesting exposition, Professor Drehschmidt mentioned that there would by the autumn be 1000 high-pressure inverted gas-lamps installed for public lighting in Berlin. Tests had conclusively demonstrated their superiority to electric arc lamps. These lamps afforded a mean lower hemispherial illuminating power of 4000 Hefners (= 3640 candles), for a gas consumption at the rate of 0·7 litre per Hefner (that is to say, the duty is about 36½ English candles per cubic foot of gas consumed). The lamps about to be installed in Berlin would be partly 2000 Hefner and partly 4000 Hefner-power.

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In the course of the James Forrest Lecture, delivered by Dr. Francis Elgar, F.R.S., at the Institution of Civil Engineers last Tuesday, he made the following remarks on the future power for the propulsion of ships: "We have since heard of gas and oil machinery for 16,000 H.P. battleships; but this only exists at present in imagination. It is impossible for anyone to judge, by what has been achieved up to the present in this direction, what weight or space, or what consumption of fuel, would be required for the internal-combustion engines of great power that might, perhaps, ultimately be made to fulfil the onerous requirements of marine work. Engineers and metallurgists may, by working together, succeed some day in overcoming the difficulties of producing large cylinders which will stand the high impulses and great and rapid variations of temperature that occur with internal combustion; but till that is accomplished no great step ahead can be taken. There are no two opinions, however, as to the advantages that might be gained by doing away with the present boilers and their appurtenances, and abolishing with them that very arduous and disagreeable class of labour known as marine stoking."

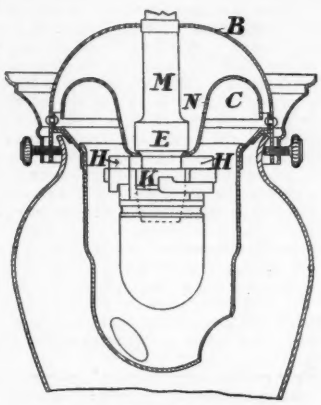
# REGISTER OF PATENTS.

## Inverted Incandescent Gas-Burners.

DEUTSCHE GASGLÜHLICHT AKTIENGESELLSCHAFT (AUERGESELLSCHAFT), of Berlin.

No. 12,624; May 30, 1906. Date claimed under International Convention, June 7, 1905.

This invention has reference to an improved deflector or envelope (of the type described in patents No. 5769 of 1900, Nos. 24,228 and 22,562 of 1903, and No. 8698 of 1905) for use in connection with inverted incandescent gas-burners for the purpose of causing the hot gases ascending from the mantle to partake of an outwardly-directed radial path—away from the downwardly travelling air entering the mixing-tube of the bunsen.




A German Inverted Gas-Burner.

The envelope N is arranged upon the mixing-tube M; being held there owing to the fact that it is clamped by the burner-head K screwed on the lower end, against the widened part E of the mixing-tube. The upper end of the envelope merges into a downwardly bent-over edge, so that between this latter and the envelope N the annular passage C for the combustion gases is formed. The edge is provided with lateral recesses in order to permit of carrying off the combustion gases in such a manner that they are not able to come into contact with the incandescent body or the reinforcing part of the burner itself—for example, the bow-shaped part B.

The combustion gases rising from the incandescent body are not able to come into contact with the mixing-tube; being kept away from it by the envelope surrounding the mixing-tube. As the envelope N is arranged above the burner-head K (preferably manufactured of ceramic material) or the incandescing body holder H, the burner-head may be given such a shape, quite independently of the envelope, that the space between it and the incandescing body support is sufficiently large for the unimpeded carrying-off of the combustion products. In addition to this, the combustion gases are able to escape freely upwards.

## Manufacture of Gas for Illuminating, Heating, or Power Purposes.

ELWORTHY, E. G., of St. Albans.

No. 13,480; June 12, 1906. Date claimed under International Convention, June 17, 1905.

This patent specification opens with a reference to two previous patents granted to H. S. Elworthy and E. H. Williamson, No. 12,461 of 1902 and No. 7713 of 1905. In the first of these, various forms of a process were described whereby water gas (defined as any gas obtained by passing steam through incandescent fuel) was converted into a gas rich in methane by passing it—with or without the addition of hydrogen, and with or without abstraction of carbon dioxide or monoxide—over heated nickel at suitable temperatures, so as to convert the hydrogen and the oxides of carbon present into methane and water. In the second specification, methods were described according to which processes of the character mentioned in the previous one were carried out in the presence of an excess of hydrogen, with the object of facilitating the reaction and rendering the conversion into methane more complete.

As is known, the present patentee (the widow of the late H. S. Elworthy) remarks, water gas generally contains approximately equal volumes of hydrogen and carbon monoxide, and as the reaction involved in the conversion of carbon monoxide and hydrogen into methane and water as described, theoretically requires 3 volumes of hydrogen per volume of monoxide, it is generally necessary to add to the water gas at least an equal volume of hydrogen. Similarly when the water gas contains carbon dioxide, and this is to be converted also, the carbon dioxide requires 4 volumes of hydrogen for its conversion. This has hitherto made it necessary, in order to obtain a complete reaction, to employ a separate hydrogen generator in conjunction with the water-gas generating plant and to mix the gases before subjecting them to the action of the nickel.

By means of the present invention, however, the expense and complication thus introduced are said to be avoided, and the whole of the hydrogen necessary for the conversion is produced by treatment of the water gas.

It is known that by heating water gas and steam in the presence or

not of nickel or other metals, they can be converted into carbon dioxide and hydrogen; and it has been proposed in certain applications of this reaction ($CO + H_2O = CO_2 + H_2$) to remove the carbon dioxide from the resulting mixture. According to the present invention, this known reaction is utilized as a step in the manufacture of gas by processes of the character described in the earlier specifications. The reaction is exothermic; the molecular quantities liberating about 8964 gramme-units of heat. Heat is, of course, absorbed in raising the gases to the temperature of reaction; this requiring about 14,826 gramme-units per molecule.

According to the present invention, the water gas, or a portion of it, used in the manufacture of gas by processes of the character described in the prior specifications is heated with steam, preferably in the presence of a metal, such as nickel or iron, to a sufficient temperature to produce the reaction just mentioned; and the hydrogen thus produced, which is about equal in volume to the carbon monoxide acted upon, mixes with the hydrogen present in the water gas and with the carbonic acid formed. The carbonic acid can be separated before or after the passage over the nickel of the mixture to be converted, or in cases where it is desired to convert both carbon monoxide and carbonic acid into methane by combination with hydrogen, the carbonic acid (or a suitable proportion of it) may be allowed to remain in the gas.

The removal of the carbonic acid can be effected by any suitable chemical or mechanical method—for example, by absorption with alkalies, alkaline earths, or carbonated alkalies, which may be regenerated for re-use by any known process; or the carbonic acid may be separated by centrifugal gas separating apparatus or by diffusion if preferred. Or with the same object the method of absorption in water under pressure may be employed; the other gas or gases contained in the mixture being practically insoluble. In this case it is preferable to compress the mixture of gases to about 4 atmospheres, and to pass the compressed mixture through a counter-current of water in an extractor or scrubber such as that described in the Elworthy and Williamson patent No. 14,333 of 1904. The carbonic acid is thus absorbed by the water; the insoluble gas or gases passing on into a gasholder, while the water is led into a separator wherein the pressure is relieved and the carbonic acid liberated. The carbonic acid can then be collected and utilized in any way; the water being returned to the extractor and used continuously.

Ordinary water gas contains approximately 52 per cent. of hydrogen, 40 per cent. of carbon monoxide, and a small quantity of impurities, which latter can be removed by careful washing. If, for example, a water gas be taken possessing the following composition:—

| | |
|---|---|
| $H_2$ | 52 per cent, |
| CO | 40 ,, |
| $CO_2$ | 4 ,, |
| Impurities | 4 ,, |

there are obtained, say—

52 per cent. $H_2$ + 40 per cent. $H_2$ produced = 92 volumes $H_2$
4 ,, $CO_2$ + 40 ,, $CO_2$ ,, = 44 ,, $CO_2$
4 ,, impurities . . . . . 4 ,,

140 volumes of mixture.

Or, reducing this to percentages, the composition is approximately—

| | |
|---|---|
| $H_2$ | 65·22 |
| $CO_2$ | 31·89 |
| Impurities | 2·89 |
| | 100·00 |

The carbonic acid can be removed or not, as explained. But, instead of carrying the hydrogen producing reaction to the point indicated, it may be carried only to such a point as to give a mixture containing carbon monoxide and hydrogen in proportions suitable for the production of methane by processes of the kind described. This may be effected by suitably proportioning the quantity of steam introduced into the reaction chamber, or by adding, if necessary, untransformed water gas.

For example, if a water gas of the composition already indicated be taken, this result can be obtained by converting a portion of the carbon monoxide into carbonic acid. For example—

| Water Gas Taken. | | Resulting Gas. | |
|---|---|---|---|
| $H_2$ | 52 per cent. | 52 + 17 = 69 $H_2$ | in volumes. |
| CO | 40 ,, | 23 = 23 CO | |
| $CO_2$ | 4 ,, | 17 + 4 = 21 $CO_2$ | |
| Impurities | 4 ,, | 4 = 4 Impurities | |

The carbonic acid and other impurities can be removed as already described if desired.

In patent No. 7713 of 1905, the advantages which are secured by employing an excess of hydrogen in the mixture subjected to the action of nickel in making gas according to the prior specifications were explained, and the commercial value of the gaseous mixture of hydrogen and methane thus produced was pointed out. The process of the present invention may be carried out in such a manner as to produce hydrogen and carbon monoxide in suitable proportions to obtain a resulting mixture containing such an excess of hydrogen over the carbon monoxide present, or to produce hydrogen and carbon monoxide in any desired proportions, mixed with a certain quantity of impurities, the amount of which can be considerably reduced by washing.

It is evident that the hydrogen obtained, as in the first example given, may be mixed with the methane obtained by passing the products obtained according to the second example over nickel, as described in the earlier specifications. It is likewise evident that the hydrogen or hydrogen and carbonic acid obtained in the manner illustrated by the first example may be mixed with the products obtained by working as illustrated in the second example, before passing the mixture over the nickel for the production of the commercial gas before mentioned; and the carbonic acid may be removed before or after the reaction in the nickel chamber. The hydrogen produced may likewise be treated in combination with the carbonic acid produced in the water gas and steam reaction, for the production of methane under the conditions described in the prior specifications.

If desired, a portion of the carbon monoxide present in the water gas may be removed by centrifugal action or by diffusion prior to the treatment of the water gas with steam, so as to have only a sufficient proportion of monoxide in the gas to allow of producing the required proportion of hydrogen or carbon monoxide for the methane producing reaction; the residue of the carbon monoxide being separated from the impurities and utilized for heating.

For example, assuming the water gas to possess the following composition:—

| | |
|---|---|
| $H_2$ | 52 per cent. |
| CO | 40 ,, ,, |
| $CO_2$ | 2 ,, ,, |
| Impurities | 6 ,, ,, |

By removing about 23 per cent. of the carbon monoxide, there is—

| | | |
|---|---|---|
| $H_2$ | 52 per cent. | 69 per cent. for the methane reduction. |
| CO | 17 ,, ,, | |
| | 23 ,, ,, | |
| $CO_2$ | 2 ,, ,, | 31 per cent. for heating. |
| Impurities | 6 ,, ,, | |

Similarly the product obtained by heating water gas and steam in the manner illustrated by the first example may be similarly treated for the removal of the carbonic acid, so as to leave only a sufficient proportion of this latter for the methane producing reaction; the residue of the carbonic acid being collected and used as a bye-product. For example—

| | | | |
|---|---|---|---|
| $H_2$ | 65·22 .. | 65·22 | 81·525 for methane. |
| | | 16·305 | |
| $CO_2$ | 31·89 .. | 15·585 | 18·475 as a bye-product. |
| Impurities | 2·89 .. | 2·89 | |

In any case a larger quantity of carbon monoxide may be removed in the first case, or a larger quantity of carbon dioxide in the second case, so as to have an excess of hydrogen in the mixture to be submitted to the methane producing reaction, and thus obtain, as the product of this conversion by the metal, a gas composed of methane and hydrogen in certain proportions, instead of pure methane.

## Incandescent Gas-Mantles.

ATKINSON, T. N., of York Place, W.

No. 22,571 of 1906; but dated, under Patent Office rules, Jan. 12, 1907.

This invention consists of, firstly, a composition of certain mineral, metallic, and vegetable substances, whose catalytic action upon coal gas in the presence of atmospheric air raises it to such a degree of incandescence (through the condensation and combination of oxygen and hydrogen) as to ignite the gas; and, secondly, a solution of certain materials which is used for the purpose of stiffening and strengthening the mantles so that they may be handled without breakage, and which is to be burned off in the usual manner before lighting-up the mantle.

In making the mantle, the stocking is knitted or woven in the ordinary way, and saturated with nitrate of thorium, &c., as usual; the improvements being applied subsequent to the burning-out of the web or foundation. After being shaped over the bunsen burner, in either of two alternative ways, the igniting composition is used.

If applied to the mantle by dipping, spraying, or painting on, there is mixed together with water to a suitable consistency—

Composition No. 1 (A). $4\,CaCl_2 + 6\,NH_4Cl + C_6H_{12}O_6 + 2\,PtCl_4$.

This may be applied round the collar or top, and along the side of the mantle.

The alternative application is—

No. 1 (B). $3\,CaCl_2 + C_6H_{12}O_6$,

which is mixed to a stiff paste with water, which is then moulded, in the shape of a small pill, round a fine platinum wire about 2 inches in length. Another paste is made by mixing with water—

No. 1 (C). $2\,NH_4Cl + 2\,PtCl_4 + C_6H_{12}O_6$

With this paste, the pill on the wire is coated, and is allowed to set. The end of the wire is attached to the side of the mantle, preferably about an inch below the collar on the inside of the mantle. This wire and pill is the self-igniter when the gas is turned on, and may be fixed on to the mantle either before or after a stiffening composition (as follows) is applied:—

Composition No. 2. $6\,NH_3 + 12\,H_2O + 2\,C_6H_{12}O_6 + 2\,C_6H_{22}O_{11} + HgS$.

To a solution of ammonia, of a density of ·880, are added gum arabic, glucose, and vermilion, in the proportions given. This is applied to the mantle by spraying or dipping, and the mantle is allowed to dry, when it is ready for use.

The property of platinum in a finely-divided state (called spongy platinum or platinum black, according to its degree of fineness) as a gas-igniter has long been known; but the continued action of heat upon it causes it to become more dense, and it then loses this power. The present patentee proposes, therefore, to mix powdered $NH_4Cl$ with the $PtCl_4$; and the $NH_4Cl$ being roasted out when heated, the platinum is left more porous, and so has a larger surface on which to condense the oxygen, which thus causes it to act more rapidly. Another objection to the use of spongy platinum as a gas-igniter is overcome by the introduction of calcium chloride. Spongy platinum after exposure for some time to moist air, loses its power of ignition. This is caused by the oxygen condensed on the surface of the platinum having slowly combined with the hydrogen drawn from the air, until it is saturated, when combination ceases. Calcium chloride, however, is "a most energetic absorbent of hydrogen," and the core of the pill, being composed of this substance, acts as a desiccating agent, and absorbs the moisture from the surface and allows the pill to retain its power of action.

## Twin-Scoop for Charging Gas-Retorts.

WEST, J., of Manchester.

No. 16,735; July 24, 1906.

This invention, relating to machines for charging gas-retorts, has for its object an improved form of twin-scoop charger for depositing the coal in the retort. In patent No. 7965 of 1903, there was described a pa r of scoops supported at both ends in bearings attached to a central bar or cantilever fixed at one end to a charger carriage. In the present invention, the charger scoop supporting carriage travels along the track of the charging machine framework in a similar way, where either a single semicircular scoop is employed or the double scoop as described in the 1903 patent; but in this latter patent, the scoops are made up of several pieces with hinges, and a device for raising the scoops above the coal by means of chains. In the present invention, too, the charger consists of two scoops, parallel with each other and fixed at one end in a similar way to chargers having but one single scoop. These two scoops form a twin-scoop charger, and are provided with mechanism to revolve the scoops in opposite directions; and, in addition, the scoops, instead of being semicircular and in one piece, will each be made up of two hinged pieces, which, when the scoops are in a position for receiving the coal, are kept open by pawls, which come into operation as the scoops are being righted after the charger has been withdrawn from the retort. In this invention, the scoops are only supported at one end, and are without the centre bar or backbone required in the form of twin-scoop charger described in the 1903 patent.

Fig. 1 is a side elevation of the main framework of a travelling retort charging machine and which supports the charger carriage to which the scoops are fitted. This machine is provided with motors and gear for travelling the machine along the retort-house and adjusting the charger opposite to the retort to be charged. Fig. 2 is an elevation, and Fig. 3 is a plan of the twin-scoop charger and carriage. Figs. 4 and 5 are enlarged views of the charger carriage and scoops, and the mechanism for rotating them when they discharge the coal and reversing them to the position for receiving the fresh supply of coal. Fig. 6 is a section showing the charger carriage and the fixed track, which is part of the main framework of the machine. Fig. 7 is a cross section through the charger scoops when in a position to contain the coal; and fig. 8 is a cross section through the charger scoops when they are reversed to discharge their contents. The scoops are here shown with the side hinges on the outside; but the hinges may, if preferred, be on the inside.

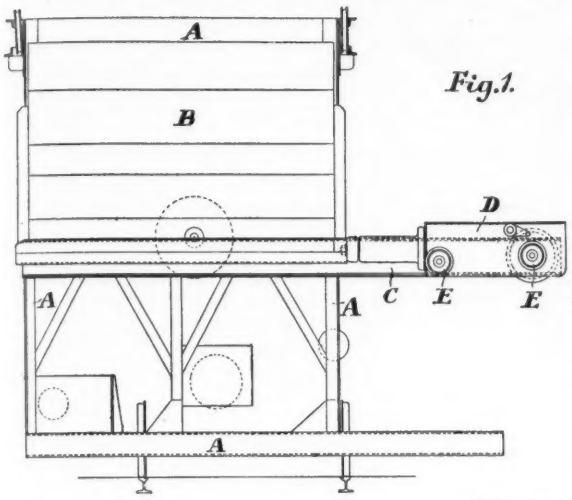



Fig. 1.

Fig. 2.

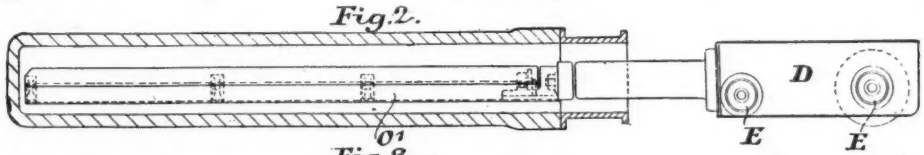



Fig. 3.

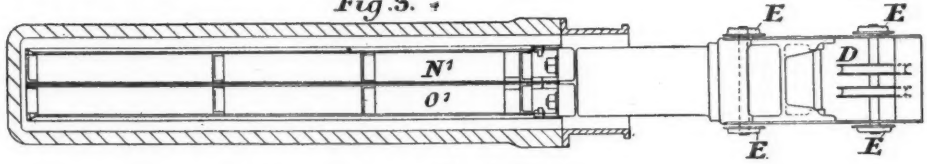



Fig. 4.

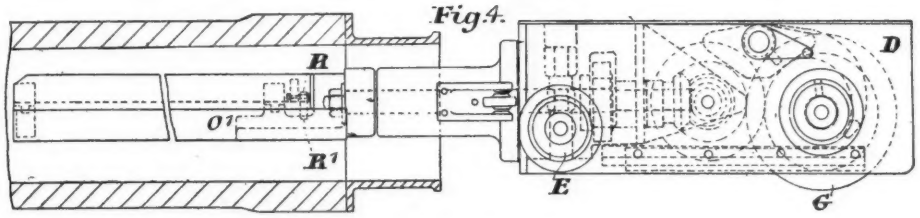



Fig. 5.

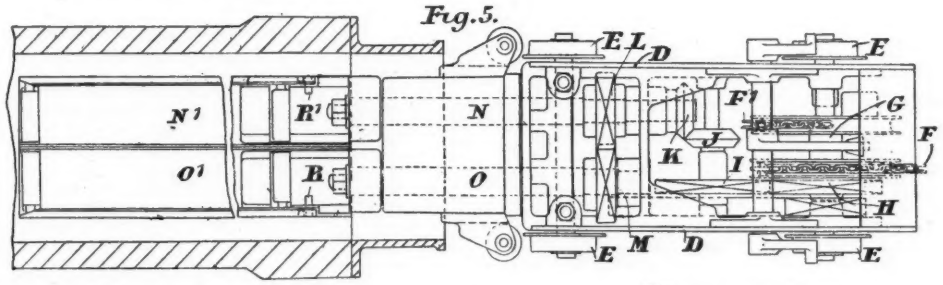
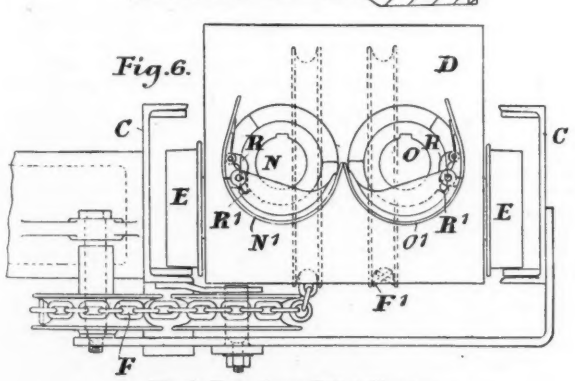



Fig. 6.




West's Twin-Scoop Retort Charger.

Fig. 7.

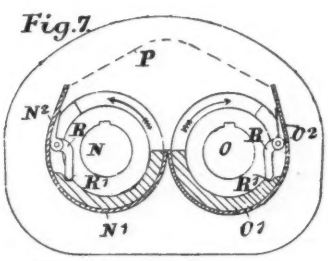
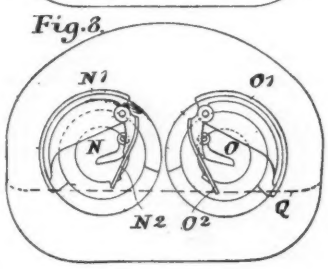



Fig. 8.



A is the main framework of the charging machine containing a coal-hopper B, provided with feeding gear for supplying the coal to the scoops of the charger when the latter is in the frame and in the position shown in fig. 1. C is the track in which the charger carriage D is supported, and also along which it travels to and fro when entering and returning from the retort. The charger carriage D is provided with wheels E, which travel along the sides of the track C. F and $F^1$ are hauling chains, which lead round pulleys at the end of the track and are connected with the mechanism and motor for driving the charger in and out of the retort; and these chains at the charger carriage end are attached to a drum G in such a way that, by reversing the direction of the pull of the chains, the drum is caused to make a partial revolution—limited by stops—and to operate gear wheels H, I, J, K, L and M, and thus cause the scoop-shafts N and O to rotate.

To one end of the scoop-shaft N is attached the scoop $N^1$, and to one end of the shaft O is attached the scoop $O^1$. The scoops $N^1$ and $O^1$ have hinged sides; and when the sides are arranged as in fig. 7 the shafts N and O are plain, but when they are arranged on the outside of the scoops the shafts have cranked ends, and in rotating to discharge the coal they move away from each other a sufficient distance to allow the coal to fall between them into the retort.

The arrows indicate the direction that the scoops rotate when they are reversed for discharging the coal. The dotted line P in fig. 7 indicates the coal in the scoops before discharging it, and the dotted line Q in fig. 8 indicates the coal on the floor of the retort after the scoops are discharged. The scoops are shown reversed as when discharging the coal; and it will be seen that the hinged sides $N^2$ and $O^2$ fall away from each other, and thus leave a space between them for the passage of the coal. When the scoops are constructed as in fig. 7, the hinged sides are provided with pawls R, which, in the position shown, fall into notches $R^1$ formed in the headstock of the scoops. These pawls keep the sides from falling inwards when the scoop is ready for receiving the coal; but they fall out of gear when the scoops are reversed as in fig. 8.

By this invention the patentee claims to be able "to construct a double-scoop charger of such dimensions that it will contain a maximum weight of coal per charge; and by the provision of the hinged sides, space is provided for delivering all the coal from the scoops when they are discharged by turning them towards the direction which will spread the coal outwards and towards the sides of the retort, and thus deposit an even layer of coal in the retort."

## Reducing the Arsenic in Coke.

DRINKWATER, T. W., and O'CONNOR, H., of Edinburgh.

No. 29,599; Dec. 29, 1906.

In coke as usually made, either as a residual in the manufacture of gas from coal or when manufactured as a main product, there is left (the patentees points out) a varying quantity of arsenic, either fixed or volatile, combined with one or other of the constituents of the coke; and for certain manufactures it is important that the quantity of such combined arsenic should be reduced to a minimum. The object of their invention, therefore, is to so treat the coal before coking that the combined arsenic is either partially driven off or rendered non-volatile in the process of coking.

To effect this, they sprinkle over the coal before carbonization a quantity of common salt or any other chloride which is volatile when heated, or a mixture or mixtures of these. When the coal thus sprinkled is being converted into coke by the volatilization of its gaseous products, the arsenic, probably combining with the chlorine of the chlorides, will pass away with the gaseous products as chloride of arsenic, thus reducing the original amount of arsenic, either fixed or volatile, or both, present in the coal.

## APPLICATIONS FOR LETTERS PATENT.

5231A.—GEORGES, J., and DORMOY, E. A., "Cleaning water-pipes." June 14.

13,381.—BRIERLEY, J., "Mantle-rod." June 10.

13,413.—COWPER-COLES, S. O., "Smokeless fuel." June 10.

13,477.—PITNER, M. W., "Pendant mantle gas burners." June 11.

13,533.—TWYFORD, T. W., and MOORE, T. C., "Gas-fired kilns." June 11.

13,550.—BENTLEY, G. H, and HOPKINSON, R. A., "Removing tar and other impurities from producer and like gas." June 12.

13,575.—QUINCEY, S., and HARRISON, C., "Gas-pendants." June 12.

13,620.—SIEMENS, F. C., "Regenerative gas-furnaces." June 12.

13,648.—HELPS, G., "Gas-lamps." June 13.

13,652.—HELPS, G, "Gas-lamps." June 13.

13,653.—HELPS, G., "Globe-holders." June 13.

13,655.—BEARD, G. F. H., and R. & J. DEMPSTER, LIMITED, "Tubes of water-condensers for gas-works." June 13,

13,665.—MARILLIER, F. W., and STANTON, T., "Inverted burners." June 13.

13,763.—CHERRY, C. E., "Inverted burner." June 14.

13,765.—THORP, T., "Rotary gas-meters." June 14.

13,804.—SIEMENS, F. C., "Regenerative gas-furnaces." June 14.

13,827.—WESTON, A. H., "Inverted burners." June 14.

**A Smaller Profit at Bradford.**—The balance-sheet of the Bradford Corporation Gas Committee shows that the total income for the past year has been £286,800, and the expenditure £221,344. The balance to net revenue account amounted to £65,456; and interest and sinking fund accounted for £61,970—leaving a net profit for the year of £3486, as against £6000 in the preceding year. The decrease is attributed to the falling off in the consumption of gas and to the low prices which have been obtained from the sale of residuals. There remained unappropriated at the commencement of the year £5437, which, together with this year's profit of £3486, totalled £8923. There has been transferred to relief of rates the sum of £5000, leaving £3923 as unappropriated balance. The capital value of the works and sundry assets amounts to £1,309,227.

# CORRESPONDENCE.

*[We are not responsible for opinions expressed by Correspondents.]*

## The Worthing Gas Company and their Parliamentary Success.

SIR,—I think the triumphant passing of the Bill of the Worthing Gas Company, in the face of the most persistent opposition in both Houses (even amounting to persecution) is an event that should not be forgotten by the gas industry.

There are two points specially worthy of notice. It was contended that there was no precedent for giving permission to a gas company to erect works on land which they had provisionally purchased, if the neighbouring landowners objected; and I think it was expected that the House of Lords would not make a precedent. The Counsel for the Worthing Gas Company—Mr. Honoratus Lloyd, who most ably conducted the case—was going to deal with the point, saying [question 2116] one word "with reference to what you call precedents," when he was stopped by the Chairman, the Earl of Donoughmore, who said: "It has been laid down here many times that we are here to make precedents not to follow them." Mr. Honoratus Lloyd thereupon remarked: "I am obliged to your Lordship. Then I will not trouble about it." And the Chairman concluded: "Each case must be decided on its individual merits."

The words of the Chairman first quoted should be written in letters of gold.

The other point of great importance is the knock-down blow that the Committee gave to the unjust contention that gas-works are "an intolerable nuisance," and cause great depreciation in the value of property in their vicinity. The able Counsel for the opponents asked for a compensation clause, saying: "They are prohibited from creating a nuisance, and that is all"—referring, I suppose, to the general law. He then said: "If independently of that the Committee come to the opinion that it is probable that damage may be done by the construction or user of the gas-works, then I submit it is a proper case for compensation" [to the neighbouring landowners, of course]. The Chairman said: "I do not think we would have given them the site if we had thought that." Mr. J. D. Fitzgerald retorted: "But if it is possible—reasonably possible—that damage will be done, who ought to suffer the damage? Ought the damage to fall on the innocent landowner who adjoins or on the Company who do the damage?" The Chairman replied: "I think you have been trying for three days to persuade us that damage will fall on the innocent landowner, and we have decided against it."

This also ought to be written in letters of gold, for it is the best answer that could be given to the common prejudice one finds against gas-works.

One word, in conclusion, for the little Company who have carried through this great fight. If it were possible to subscribe towards their expenses, it would be a just and graceful act; but it cannot be done. We can, however, give our warm thanks to their Chairman and Directors for the great service they have rendered to the gas industry, and offer our hearty congratulations on their success.

I have never known more persistent and bitter opposition which was met manfully, with even temper and quite fairly. It only remains to express the hope that the Company may long enjoy the peace and prosperity they richly deserve.

GEORGE LIVESEY.

*June 21, 1907.*

## Protecting Meter-Couplings.

SIR,—With your permission, I would like to say how interested I am to see the meter-coupling protector of my creation (patent No. 11965 of 1894) appear in a meter manufacturer's advertisement in your columns, in the preliminary stages of a patent application. It is true that the device shown is only held together by a seal, a point of difference between it and my own I naturally think is in favour of the latter. It is, however, a sign of the requirements of the times that such a device is put forward by the trade. I think it would be hard to find any other commodity supplied to the public where such confidence is reposed in the integrity of the customer as is shown in the means employed in coupling the unregistered supply of gas to the meter. I do not suggest such confidence ought not to exist, but would rather say that it is not business. Doubtless in the earlier days of gas supply the ignorance of the public generally on gas matters was quite sufficient protection for the couplings then and still in use; but knowledge of such matters among the general public is very different in these times, and the honest customer should be protected from imputation, equally with the gas from the dishonest customer.

I may add that I write this with a fair knowledge of the various sealing devices in existence, most of which require a special form of coupling or cock—a matter which stands more or less in the way of their general adoption. My idea, as embodied in my lapsed patent, is that the present form of union, coupling a main cock or meter inlet, should have its ring encased (after coupling up) in such a manner as to prevent the application of a tool by which the ring may be unscrewed by an unauthorized person.

G. J. COX, Chief Meter Inspector,

*Metropolitan Gas Company, May 21, 1907.*

## Coke.

SIR,—A question having arisen as to the permissible amount of moisture in coke, I have made inquiries of various gas managers, more particularly to ascertain what specification would be accepted as regards the limitation of such amount of moisture, and have obtained answers to the following effect.

The chief engineer of gas-works in a large city in the Midlands states that it is very difficult to maintain anything like a uniform percentage of moisture in coke, which besides the ordinary careful quenching is

mostly subject to heavy rains. But, on an average, he considers that 6 to 8 per cent. of moisture is such as would avoid complaints from purchasers.

The engineer of a gas company in a fairly large town in the East of England states that it is only on very rare occasions that the amount of moisture would exceed 5 per cent.; but in a specification to which the company supply, they are limited to not more than 8 per cent.

The gas manager in a large city in the East of England states that he does not consider 5 to 11·3 per cent. of moisture is excessive.

The engineer of a gas company in an important seaside resort in the East of England considers that 11·3 per cent. of moisture would be very high.

The engineer of a corporation gas-works in a city in the North-East of England expresses his inability to state what constitutes a fair allowance of moisture in coke. He regards a specification to supply coke "newly made, large, clean, dry, and made from the best Durham coking coals or Yorkshire washed nuts" as "simply impossible." He further states the condition of the coke, if stored in an open yard, depends on wet or dry weather.

The engineer of a gas company in a manufacturing town in the South of England thinks there is little cause for complaint with from 5 to 11 per cent. of moisture.

The manager of a gas company in an important seaside town in the West of England states he should not like to be bound to supply coke continuously with less than an average of 7½ per cent. of moisture.

An expert, who is not a gas or coke manufacturer, informs me that the amount of moisture should not exceed 4 per cent.

As this matter is somewhat important in settling contracts for the purchase of coke, it would be advantageous if your readers with a knowledge of the subject would contribute their opinion.

*Norwich, June 21, 1907.* ARTHUR E. COLLINS, City Engineer.

# PARLIAMENTARY INTELLIGENCE.

## HOUSE OF LORDS.

The following further progress has been made with Bills:—

Bills reported, with amendments: Brighouse Corporation Bill, Grays and Tilbury Gas Bill.

Bills read the third time and passed: Gas and Water Orders Confirmation Bill (No. 1), Grays and Tilbury Gas Bill.

## HOUSE OF COMMONS.

The following further progress has been made with Bills:—

Bill brought from the Lords, read the first time, and referred to the Examiners: Gas and Water Orders Confirmation Bill (No. 1).

Lords Bills read a second time and committed: Renfrewshire Upper District (Eastwood and Mearns) Water Bill, Wisbech Water Bill.

Lords Bills reported: Birkenhead Corporation Water Bill, Devonport Corporation Bill, Southport, Birkdale, and West Lancashire Water Board Bill.

The Sheffield United Gaslight Company have presented a petition against the Sheffield Corporation Bill.

The Ashton-under-Lyne, Stalybridge, and Dukinfield (District) Water-Works Bill and the Renfrewshire Upper District (Eastwood and Mearns) Water Bill [Lords] have been referred to a Select Committee, consisting of Major Seely (Chairman), Mr. Duffy, Mr. E. A. Strauss, and Mr. Lewis Haslam; to meet on Thursday next.

## UNOPPOSED BILLS.

On Monday of last week, Lord ONSLOW, the Lord Chairman o Committees of the House of Lords, had before him the Gas and Water Orders Confirmation (No. 2) Bill.

### Twyford (Berks) Gas Order.

In this Order, empowering the Twyford (Berks) Consumers' Gas Company, Limited, to maintain and continue gas-works and to manufacture and supply gas in certain parts of the county of Berks, and for other purposes, the share capital for the purposes of the undertaking is not to exceed £13,000, consisting of £4300 share capital already raised and of additional capital to be issued subject to the provisions of the Order not exceeding £8700, including any premium which might be obtained on the sale of shares or stock. The amount of all the moneys borrowed and secured by mortgage of the undertaking is not to exceed one-third of the capital actually raised by the issue of shares or stock; and no higher rate of interest than 5 per cent. per annum is to be paid without the consent of the Board of Trade in respect of moneys borrowed after the commencement of the Order. The undertakers are empowered to purchase, take on lease, or acquire, in addition to the lands described in the schedule, any lands which they would require, provided that they shall not hold more than 3 acres in the whole in addition to the lands described. They may continue or discontinue their existing gas-works and works connected therewith for the manufacture and storage of gas, coal, coke, and ammoniacal liquor, and, subject to the Order, may manufacture gas and distribute the same within the limits of supply. Clause 21, giving power to contract for the sale of gas in bulk, has been substituted by the following:—

The undertakers may contract with any local authority, company, or person supplying gas under parliamentary powers, in any district adjacent to the limits of supply, for the supply to them respectively of gas in bulk upon such terms and conditions and for such periods not exceeding seven years from the making of such agreement as may be agreed upon; but nothing in this section shall authorize the undertakers to lay any mains or interfere with any streets beyond the limits of supply.

Clauses are also inserted for the protection of the Berkshire County Council and the Great Western Railway Company. The quality of the gas supplied is to be equal to 14 candles; and the price shall not exceed 5s. per 1000 cubic feet. On the expiration of three years, the Board of Trade may alter the maximum price, either by substituting another sum or by fixing a standard price with a sliding-scale.

The Bill was ordered to be reported.

# LEGAL INTELLIGENCE.

## HIGH COURT OF JUSTICE—CHANCERY DIVISION.

**Thursday, June 20.**

(*Before Mr. Justice* KEKEWICH.)

### Cranleigh Water Company, Limited, v. Austen.

This was a special case for the opinion of the Court as to whether the plaintiff Company had power to take on lease from the defendant, and whether the defendant had power to grant easements, rights, or privileges, notwithstanding the fact that the period of three years had elapsed from the date of the Provisional Order. The Company was incorporated in December, 1855, and obtained from the Board of Trade a Provisional Order empowering them to construct and maintain water-works and supply water in the parish of Cranleigh and part of the parish of Wonersh, in Surrey. The defendant granted to the Company a lease, dated July 13, 1886, whereby a certain piece of land was demised to them for a term of 999 years. Plaintiffs duly constructed the works authorized, and had been for some time carrying on the business of a Water Company. Owing to the increase in the population within the area of the Company's limits, it had become necessary to enlarge and extend the works; and for this purpose they desired to acquire from the defendant upon lease, and by way of demise for a term of years, certain rights of collecting water in and upon certain rights of way over additional lands. As the three years from the date of the Order had long since expired, this friendly action was instituted to ascertain the rights of the parties.

Mr. LAWRENCE, K.C., and Mr. MAUGHAM appeared for the plaintiffs; Mr. G. J. WOOD represented the defendant.

Justice KEKEWICH held that the Company had power, under the terms of the Order, to take on lease; that the defendant, who was tenant for life of the property, had power to grant easements, rights or privileges; and he made an order accordingly.

## HIGH COURT OF JUSTICE—KING'S BENCH DIVISION.

**Wednesday, June 19.**

(*Before the* LORD CHIEF JUSTICE, *and Justices* DARLING *and* LAWRENCE.)

### Rex v. Hutton (Metropolitan Police Magistrate), ex parte Watson.

In this case, Mr. G. JONES appeared to show cause against a rule which had been granted for Mr. Hutton to hear and determine a summons taken out by the Metropolitan Water Board against Mr. Watson, a consumer, to recover 19s. 2d. due for water supplied to him at 389, New North Road. The summons came in the first instance before Mr. Fordham on the 18th of March, and was then adjourned to the 15th of April, when it came before Mr. Hutton, at North London. His Worship decided that he could not hear the summons because the water supply had not been cut off; the proceedings being taken, as he was informed, under section 74 of the Water-Works Clauses Act, 1847, with which section 140 of the Railway Clauses Act was incorporated. This section provided that in case of default of payment, the undertakers might cut off the supply, and recover the rate due and the expense of cutting off. The learned Magistrate, being of opinion that cutting off the water was a condition precedent to the taking of any proceedings under the section, dismissed the summons. Counsel admitted that under section 21 of the Water-Works Clauses Act, 1863, there was ample power to a water company to recover water-rates without any necessity to cut off the water; but the Board had not seen fit to proceed under this section.

The LORD CHIEF JUSTICE said there were numerous cases in which Magistrates had entertained summonses for water-rates: and he asked to see the one granted in the present case.

On the summons being produced, it was found that it did not specify any section under which it had been issued.

Mr. JONES said the Magistrate asked the collector for the section of the Act which gave him jurisdiction; and he was referred only to section 74.

Justice LAWRENCE said the whole difficulty appeared to have arisen because the Magistrate was referred to the wrong section.

Justice DARLING asked if it was not the fact that a water company had power to demand payment of the rate before water was supplied.

Mr. JONES replied that they had.

Justice DARLING then pointed out the absurdity of saying that they could demand payment before they laid on the water, but could not recover before they had cut it off.

After some further discussion, their Lordships proceeded to deliver judgment—Mr. Danckwerts, K.C., and Mr. Courthope Munroe, who appeared for the Water Board, not being called upon.

The LORD CHIEF JUSTICE said there had evidently been a misconception in the case. He was satisfied, from the reported cases, that summonses for water-rates had been issued for a great many years. The

power to do so rested on section 140 of the Railway Clauses Act, under which the parties went before Justices; and now the Summary Jurisdiction Acts had in more than one case been applied to summonses for water-rates. He need only mention one case—that of the *East London Water-Works Company v. Charles;* and there were others where the question had been raised whether the power to issue a summons had been controlled by certain conditions in the Summary Jurisdiction Acts. Section 74 gave a further power to cut off the water, and to recover the expense of doing so in the same way as the water-rate, thus giving a water company an additional power. It was really almost too plain for argument. A water company had power under this very Act to claim the water-rate before the water had been supplied, which assumed that when the man had paid the rate he would get the water; and it was really a contradiction in terms to say that a company could not summon a man for the water-rate unless they had cut the water off, when *ex hypothesi* they could summon him for water to be supplied in future. The mistake had arisen from confusing the two remedies. If the summons had claimed the expense of cutting off the water, a different question would have arisen; but the only claim was for 19s. 2d. for water. He was clearly of opinion that the learned Magistrate ought to entertain this case.

Justice DARLING said to hold otherwise would be very oppressive to water consumers, as it would oblige a water company, before they could recover a rate, to stop the supply of water, which might lead to all sorts of unsanitary troubles. He could not think for a moment that the Legislature intended anything of the sort; nor did he consider the words of the section gave any reason for thinking so.

Justice LAWRENCE concurred.

Mr. DANCKWERTS said he did not ask for costs.

It was stated that a large number of summonses were standing over, pending the decision in the case.

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**Thursday, June 20.**

**Mayor and Corporation of Harrogate v. Mackay.**

This was an appeal from the decision of Justices of the West Riding of Yorkshire, sitting at Knaresborough, in February last, dismissing a summons taken out by the appellants, as the water authority, for the purpose of recovering from the respondent, a medical man practising at Harrogate, a sum of 10s. for the half year ending Dec. 25, 1906, for water used for the washing of a motor-car, which he used in the exercise of his profession, as well as for private purposes. It appeared that he had paid the charge for the two previous half years without demur; but on the present occasion he informed the collector that he disputed his liability, and declined to pay.

Mr. MACKENZIE, who (with Mr. DANCKWERTS, K.C.) appeared for the appellants, argued at some length that, the motor being used by a medical man in his business, the water employed in washing it was not used for a "domestic" purpose, and that the appellants were therefore entitled under their Act to make a special charge for it.

The LORD CHIEF JUSTICE, without calling on Mr. HORACE AVORY for the respondent, said it was decided in 1857 that using water for washing carriages was a "domestic" purpose within the terms of the Water-Works Clauses Act, 1847, and it was now too late to argue the contrary. In 1863 it was thought desirable, in the interest of water companies, to impose some limit on this, and an Act was passed. It did not, however, say anything about the carriage in which a professional man rode, but said that a supply of water for domestic purposes should not include the washing of carriages, where such carriages were kept for sale or hire, or by common carriers. He was clearly of opinion that the Magistrates had come to a right conclusion.

Justices DARLING and LAWRENCE expressed their concurrence.

The appeal was accordingly dismissed, with costs; and leave to appeal further was refused.

At a later stage, the application for leave to appeal was renewed; but the Lord Chief Justice said he thought the question was really unarguable, and that leave ought not to be given.

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## HIGH COURT OF JUSTICE—KING'S BENCH DIVISION.

**Thursday, June 20.**

(*Before Mr. Justice* GRANTHAM *and a Special Jury.*)

**Gibbons Bros., Limited, v. New Toddington Gas Company and Hale.**

This was an action brought to recover £126 14s. 7d., the balance of an account for work done and materials supplied to the defendant Company; and the question was whether the Company or their Contractor, Mr. John Chandler Hale, was liable.

Mr. M'CALL, K.C., and Mr. M'CARDIE appeared for the plaintiffs; while Mr. SHEARMAN, K.C., and Mr. EUSTACE HILLS represented the defendants.

Mr. M'CALL, in opening the case, said that Mr. Hale, in giving the orders which admittedly he did give, was acting as agent for the Gas Company. Alternatively, the plaintiffs said that Mr. Hale himself was liable. The Gas Company's case was that they gave the work to Mr. Hale, and had paid him; and that he had no authority to pledge their credit. The plaintiffs carried on business at Dudley; and a large part of it was to supply materials for gas-works. In December, 1904, the defendant Company desired to extend their works by adding retorts and other plant. They applied to the plaintiffs for an estimate; and, after correspondence, it was arranged that Mr. Hale should do the work and order from plaintiffs the materials required. At that time the plaintiffs knew nothing of any contract between the Gas Company and Hale, and they were not told that they would have to look to him. All the orders were written by him on the note-paper of the Gas Company; and it was the Company to whom the plaintiffs gave credit. They supplied goods to the value of £226 odd; and when they wrote to Hale for a cheque on account he passed their letter on to the Company, who gave a cheque for £100, payable to Hale or bearer, and Hale sent it on to the plaintiffs. This left £126 due; and the question for the Jury was whether the Company were liable.

Mr. *Stanton* gave evidence for the plaintiffs, and, in cross-examination, said he assumed that Hale's orders on the Gas Company's note-paper were given on their behalf.

Mr. *J. C Hale* deposed that, in consequence of seeing an advertisement, he interviewed Dr. White and Mr. E. Eaton, representing the defendant Company, and they agreed to give him £2 a week if he would go down to Toddington and assist their Manager to repair the works, which they had just then taken over. After he had been there a little while, he was requested to write to three firms, including the plaintiffs, for estimates for repairs. On receiving the tenders, he gave them to Mr. Eaton, and was told to accept the one submitted by plaintiffs (Gibbons Bros.), which was the lowest. He then employed men, and paid them with money received from the Company's London office. He received and paid away £90 altogether. He informed Dr. White and Mr. Eaton that he had no capital of his own with which to do the work; and Dr. White told him to get the goods from Gibbons. He had no idea of pledging his own credit.

In cross-examination, he admitted that he had sent in a tender to the Gas Company asking them to give him the contract; but it was on condition that they sent him money every week for his expenses. A contract was signed by which he undertook to do the work for £260 for the Company. He had not paid the plaintiffs because he had not received the money from the Company to do so—except £100 which was sent direct to Messrs. Gibbons. He was now in their employ.

Mr. SHEARMAN, for the defence, protested against the remarks of Mr. M'Call, in which he had tried to convey the impression (for which he contended there was no foundation whatever) that the Directors of the Gas Company were trying to evade payment. Hale had been paid by the Company, and had been getting goods on credit from the plaintiffs by pretending that he was acting for the Company. The plaintiffs had signed judgment against Hale; and finding he was impecunious, they had proceeded against the Company.

Mr. *E. Eaton*, the Managing Director of the defendant Company, said they made a contract for the work with Mr. Hale, but gave him no authority to pledge their credit. He knew nothing of the letters which had been sent to the plaintiffs, and was astonished when the claim was made upon them.

In cross-examination, witness said that he was connected with the Gas-Works Construction Company, who had promoted the defendant Company and other gas companies. He was also a Director of the Water-Works, Lighting, and Power Investment Corporation, Limited, which was also formed to promote gas and water companies.

In the result, the Jury returned a verdict for the plaintiffs for the amount claimed, and judgment was entered accordingly against both defendants. Stay of execution was granted on the usual terms.

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## SUTTON GAS COMPANY'S MAIN-LAYING OPERATIONS.

The adjourned hearing of the application by the Sutton Gas Company to lay certain gas-mains with a covering of not more than 2 feet (*ante*, p. 828) was resumed before the Epsom Magistrates on Monday of last week.

Mr. *G. J. Wooldridge*, Engineer and Surveyor to the Woking District Council, said there were 48 miles of highways repairable by that authority, and there were about 31 miles of gas-mains. During the past six years there had been considerable trouble with the mains and the service-pipes. In his opinion, the trouble was due to the insufficient depth at which the mains were laid, and to the fact that some of the rural roads were becoming more urban in character. During the past twelve months he had received 28 notices of the Gas Company's intention to open the roads. In one instance the Company gave notice of their intention to open up the whole of one road and relay the main at a depth of 3 feet. In his opinion, a gas-main in Cheam Common Road should not be laid at a depth of less than 3 feet. A covering of 2 feet would be a source of danger. Dealing with the assertion that at Sutton mains were laid with 1 ft. 9 in. of covering over which the electric trams passed, he pointed out that there would be a concrete foundation for the tram rails, and no pressure would therefore be applied to the main. The joints would be sure to fracturd when heavy traffic was passing if mains were laid at less than 3 feee in the roads in question, as there was so little material on them. Thet extra cost would be 3½d. per lineal yard, which worked out to £24 9s. per mile.

In cross-examination, witness said the nature of the soil differed considerably in the neighbourhood of Woking. He contended that a 6-inch pipe with 2 feet of covering was not sufficient to carry a roller of 10 tons. He could not explain how it was the Sutton Gas Company had laid about 8000 yards of main with 2 feet of covering without having a leakage. The safety of a pipe depended on various things—such as the nature of the soil, or the way the trench was filled in. There were no regulations at Woking; but the District Council would not pass mains with 2 feet of covering. There had been no mains laid in the roads at Woking during the past five years with a less covering than 3 feet.

By the BENCH: If there was only 6 per cent. of unaccounted-for gas with the Sutton Gas Company, it would be remarkably low; and there would be no main leakages.

Mr. *James Webb*, the Surveyor to the Hendon Rural District Council, said he had been engaged in that capacity for 13 years. The subsoil in his district was clay; and the character of the roads was similar to those in question. He had made several complaints about gas-mains which had been laid at a depth of 2 feet and under. From his experience, there was a tendency of water getting down into the trench and causing subsidence, where the subsoil was of clay. In relaying the mains the Gas Company had used 3 feet of covering. During the last few years, all mains, both gas and water, had been so laid. Formerly the Gas Company protested, but eventually found such a course would be to their advantage. The extra cost to the Sutton Company in laying the mains suggested would be about £35.

In cross-examination, witness said he had not known a single fracture at Fulham caused by only having 2 feet of covering. A great deal depended upon the bed upon which the main was laid. Even with the 6 inches of chalk covering, a heavy weight passing over would push through wet clay and make the bottom of the bench soft.

Mr. *W. T. Wooldridge*, the Surveyor and Inspector of Nuisances to the Epsom Rural District Council, said he investigated an escape of gas in York Road, Cheam. As soon as he found out the escape, the Company's workmen appeared on the scene.

In cross-examination, witness said he could not say what work the men did.

Mr. *Herbert Todhunter*, the Assistant-Manager of the Sutton Gas Company, said the main referred to by the last witness was laid with a covering of 1 ft. 9 in. He had no idea of the leakage, or of the suggested repairs.

Mr. MACKENZIE, in addressing the Bench on behalf of the District Council, said they did not appear as an opposing party in litigation. They came there to put their view of the matter before them, and had to accept their decision. Where they had roads which were likely to have traction engines going over them from time to time, this fact must be remembered when the depth of the main was determined It was common ground that the roads in question were of clay subsoil, and therefore capable of least resistance. It was also common ground that the roads were repaired with a 6-inch coating; and he asked the Magistrates to say that the mains should be laid at a depth of 3 feet. Here was a case of serious concern; and when it was remembered that the Council and ratepayers were continually being put to the expense of repairing the roads, it must be said that his clients were not unreasonable in asking them for a covering of 3 feet. It seemed that the Gas Company had taken up rather a narrow attitude in regard to this matter; for if they split the difference of the extra cost suggested by the various witnesses, it would only be about £50. The Company were trying to do their best for the consumers and their shareholders; while the Council were studying the interests of the public generally.

The Magistrates retired to consider their decision; and on their return into Court,

The CHAIRMAN said they had given the best attention they could to the case. It was a dispute that had arisen between the District Council and the Gas Company in respect to plans they had delivered for laying a series of mains in Cheam Common Road and Longfellow Road. The dispute practically resolved itself into this—*i.e.*, whether the pipes shall be laid 3 feet or 2 feet. There had been evidence of a contradictory character, which was very strong on both sides; and this added to the difficulty of the Bench giving a decision. To a certain extent, and to a long extent, the evidence was merely expert opinion, in which there was a difference of thought. The Bench came to the conclusion that 3 feet was not an unreasonable covering, and therefore their decision in this case must be in favour of the Rural District Council. He would say again, at the request of his colleagues, that this was absolutely an *ad hoc* decision. They did not go beyond this particular and individual case in any way whatever; they simply decided that thepresent dispute must be in favour of the Epsom Rural District Council.

Mr. MACKENZIE raised the question of costs; and the Bench allowed the Council twenty guineas, though the Chairman remarked that it must be taken at their own risk, as the Magistrates were not sure they had any power to make an order.

## Reduction of Messrs. W. Sugg and Co.'s Capital.

In the Chancery Division of the High Court of Justice last Tuesday (before Mr. Justice Warrington), Mr. Eve, K.C., appeared, with Mr. Martelli, in support of a petition, presented by Messrs. W. Sugg and Co., Limited, for a reduction of capital. He said resolutions had been duly passed for lowering the capital by £32,000—this amount being now unrepresented by available assets; and he thought the only point for consideration was whether the loss was made out. The various items were as follows: £477 on Vincent Street works, £1000 on the Franchcourt works at Lower Tooting, £14,400 on patents, £15,600 on plant, and £2000 on stock. He proceeded to read affidavits by Mr. J. E. Fisher, an auctioneer and valuer, of Tooting, as to the value of the works there; and by Mr. Edwin Sugg Wright, the Manager, as to the plant and machinery—a detailed valuation having been made by him, assisted by two engineers who had been more than twenty years in the Company's service. He also spoke as to the value of the stock, in regard to which evidence was also given by Mr. Illingworth, the Chairman of the Company, who stated that in the last three balance-sheets nothing had been allowed for depreciation. The amount written off the value of the patents was very large; and it was explained in the affidavits of the Chairman and Manager that the late Mr. Sugg took out a number of patents, and expended large sums on keeping them up, and experimenting with them, though many had never been put into commercial operation. On his death, the Directors had gone very carefully into the matter, and decided upon only keeping on foot a certain number of the existing patents, and on writing off the large sums expended on those which had not proved remunerative. Those which remained were not worth more than £1750; but they were worth more to the Company than to anyone else. It was also stated in the affidavits that not more than 10 per cent. of the Company's business consisted in the manufacture and sale of patented articles. His Lordship sanctioned the reduction as asked, and directed the words "and reduced" to be used for one month.

## Alleged Gas Poisoning in Glasgow.

In the Court of Session at Edinburgh last Tuesday, Lord Guthrie closed the record and ordered issues for trial by jury of an action brought by Edward M'Andrew, of No. 12, Carbeth Street, Glasgow; Elizabeth Convery or M'Andrew, his wife; and Ann M'Andrew or Convery, his mother, against the Corporation of Glasgow. The first and second pursuers sue for £250 each, and the third for £500, as damages. They state that they were occupants of a house and shop at No. 12, Carbeth Street. On Dec. 28 last, the gas-main in the street was leaking; and the escaped gas percolated through the soil and entered their premises, with the result that they were all sick and incapacitated. A daughter of Mrs. Convery's died from the effects of the gas poisoning. Carbeth Street, it is explained, is built upon a coup toom, where refuse of all kinds is emptied; and the soil thus contains many chemicals, some of which would corrode iron—a circumstance which the defenders knew, or ought to have known. It is averred that in such soil gas-mains are usually enclosed in wood, into which tar is afterwards run; and the possibility of corrosion is thus avoided. This the defenders failed to do, though it was their duty to take such steps, which would have prevented the death of the girl. The defenders explained that the pipe was constructed of the best material, and was laid in the year 1877 in a safe and proper manner, and thereafter was periodically inspected. The leakage was stopped an hour and twenty minutes after it was reported. The girl's death, it is asserted, was due to natural causes. The leakage arose from a fracture which was caused by some unknown circumstance.

**Theft of Gas at an Illicit Distillery.**—At the Marlborough Street Police Court last Wednesday, Leon Henri Perreau pleaded guilty to a charge of stealing gas from the Gaslight and Coke Company. For the Company, it was stated that this was the worst case they had ever had to deal with. In addition to other burners, there were two rings for a still, and a pipe had been so fitted that any quantity of gas could be stolen. The accused was sentenced to six months' hard labour.

**Theft of Incandescent Mantles.**—Three lamplighters named Alfred Taylor, James Frederick Davison, and Charles Albert Scott were charged at the Newington Sessions last Friday with stealing incandescent gas-mantles belonging to the Bermondsey Borough Council. Mr. Angel, the Borough Surveyor, thinking there were more mantles going out than there should be, caused some to have a special mark placed upon them; and it was then found that the three men named were not placing on the street-lamps all they took out of stock. A publican stood accused of receiving some of the mantles; but the prosecution withdrew the charge against him. Previous convictions were proved against Taylor, who was sentenced to six months' imprisonment: and Davison and Scott were bound over to come up for judgment if called upon.

## Tottenham Public Lighting.

At the meeting of the Tottenham Urban District Council last Tuesday, permission was given to the Tottenham and Edmonton Gas Company to fix Lucas lamps on every second tramway post in Green Lane similar to those in Bruce Grove; the Company undertaking to light and maintain same at the existing contract price for the Kern burners until such time as the electric arc lamps are affixed to the poles. The Council's Engineer submitted a report, which he had prepared on instructions, upon the possibility and result of adopting some other system or arrangement, such as exists in Hornsey and elsewhere, as regards street lighting. In connection with this report the General Purposes Committee recommended that a copy of it be forwarded to the Gas Company, requesting them to revise the existing scale of charges and to submit proposals for the more efficient lighting of the district, as, in the opinion of the Committee, the "C" type of burner was not satisfactory, neither was the system adopted for the renewal of the mantles. Mr. Harvey, as an amendment to the motion for the adoption of the Committee's recommendation, moved that the Engineer be instructed to submit a further report for a system of lighting for Tottenham on the lines of that existing in Hornsey. Tottenham were paying £500 a year more than Hornsey; and it was time that they had a different system in operation. Mr. Elder said that the great difference for the two districts was that the lamps were kept longer alight in Tottenham than in Hornsey. Mr. Liquorish pointed out that if Tottenham adopted the same hours as Hornsey, the two districts would be on a level as far as payment was concerned. In the result, Mr. Harvey's amendment was carried by 11 votes to 9.

## The New Water Supply for Paignton.

An application by the Paignton District Council for power to borrow £12,861 in connection with the water supply of the town, was the subject of an inquiry held last Wednesday by Mr. A. W. Brightmore, Local Government Board Inspector. It was explained that the money is required for works of distribution when the new supply from Dartmoor is available. A remarkable feature of the inquiry was the opposition offered to the scheme by Dr. Vickers, the Medical Officer of Health for the town. Mr. F. W. Vanstone, the Engineer, explained the scheme, which includes the construction of a covered reservoir and the laying of a system of new mains. Dr. Vickers complained that he had not been able to see a map of the scheme, and said that before it was carried out he should like to make a report on it as Medical Officer. Mr. Vanstone said that he had asked the Medical Officer to make an analysis of the water, and explained that provision had been made at Holne Moor for the water to pass through limestone to neutralize any tendency to lead poisoning. The water was a little peaty and slightly acid. Among others opposing the scheme, was Mr. F. O. Gadsden, a former member of the District Council, who contended that the Council should have adopted a scheme prepared by the local Surveyor, Mr. Baines, which had been recommended by Mr. Baldwin Latham, the Consulting Engineer. Mr. Gadsden also complained that the expenditure on the scheme had grown from £70,000 (the original estimate of the cost) to £110,000, and said that under these circumstances, the arrangements for supplying water to Teignmouth and Brixham would be disadvantageous, because they would be actually supplying water for less than it cost. Mr. W. J. Ham, the Chairman of the District Council, explained that Mr. Latham recommended alterations in the other schemes which would have rendered them more expensive than Mr. Vanstone's; and Mr. Vanstone expressed the opinion that the opposition was nothing but a personal matter.

# MISCELLANEOUS NEWS.

## EDINBURGH AND LEITH GAS COMMISSION.

### The Annual Accounts.

It was reported to the Edinburgh and Leith Gas Commissioners, at their meeting yesterday, that the revenue for the past financial year amounted to £325,222, of which £265,181 was from gas, £24,632 from coke, and £13,413 from tar. The balance carried to the profit and loss account is £102,120; the net balance, £23,290. From this, after meeting standing charges and wiping out a debit balance of £406 from the preceding year, there is carried forward £2911. Provision has been made for paying out of revenue the damages and expenses in the action brought against the Commissioners in respect of the pollution of Messrs. Muir's brewery well. The quantity of coal carbonized was 178,524 tons, the cost of which was £104,000; and the quantity of gas sold was 1,931,301,000 cubic feet. The additions to capital during the year were £72,784.

## EXAMINATIONS IN GAS MANUFACTURE.

### The Pass-List.

The Superintendent of the Department of Technology of the City and Guilds of London Institute (Sir Philip Magnus, M.P.) has issued the pass-list in connection with the last examination in "Gas Manufacture." The following are the names of the candidates who satisfied the Examiner, Mr. A. F. Browne, of Vauxhall:—

HONOURS GRADE.

*First Class.*

| | | | |
|---|---|---|---|
| Ablett, E. | Denham, J. | Henshaw, D. M. | Peaty, H. F. |
| Allan, A. P. | Dobson, A. | Heron, A. T. | Pickering, W. J. |
| Balcon, P. C. | Edmonds, C. H. | Hobbs, E. J. | Saville, F. |
| Barker, F. G. | Feist, J. A. | Hollis, B. W. | Sherrett, A. |
| Blincoe, C. F. | Fisher, J. | Ingham, G. | Sproxton, K. |
| Brearley, J. W. | Frith, E. | Lamprey, R. H. B. | Sturges, S. |
| Cadwallader, W. E. | Gardiner, P. C. | Last, F. A. | Townsend, C. V. |
| | Garsed, E. | MacGregor, A. | Twigg, G. F. |
| Carter, S. | Gripton, H. C. | Marshall, G. W. | Verrall, A. E. |
| Clegg, F. | Gwyn Jenkins, P. | Meade, A. H. | Williams, A. E. |
| Cooper, J. E. L. | Harris, C. | Pearce, F. J. | Young, J. |
| Cranmer, W. G. S. | Harris, J. E. | Pearson, G. C. | |

*Second Class.*

| | | | |
|---|---|---|---|
| Andrews, H. J. | Cox, G. F. | Higgins, F. | Punnett, H. |
| Bamber, G. A. | Cox, W. J. | Hill, A. L. | Richards, F. B. |
| Bartlett, O. J. | Davies, F. | Hoit, J. | Ronca, A. |
| Billingsley, H. H. | Dean, F. | Holt, C. E. | Ruthven, R. H. |
| Blenkinsop, J. P. | Dearden, R. | Hutchinson, S. | Saville, H. |
| Bolam, C. F. | Fenner, R. L. | Isaac, C. E. | Shepherd, C. C. |
| Bostock, B. R. | Fowler, J. F. | Keable, A. H. | Shepherd, W. |
| Broughton, J. T. | Gale, J. R. | Langdon, J. M. | Smith, T. W. |
| Brown, J. | Glover, R. B. | Male, F. J. | Smith, T. |
| Charlesworth, G. W. | Grogons, W. | M'Kinlay, J. | Smythe, W. |
| | Hallows, J. | Nicholl, J. W. | Thompson, F. |
| Cheshire, W. D. | Handley, H. C. | Noble, H. W. | West, T. H. |
| Clapham, H. | Hart, F. L. | Paul, H. | White, F. M. |
| Cook, R. | Hartley, D. | Porteous, W. V. | Williams, F. B. |
| Cooke, J. W. | Hayles, L. J. | Priestley, B. | Yorke, E. G. |

ORDINARY GRADE.

*First Class.*

| | | | |
|---|---|---|---|
| Aitken, H. A. | Duffill, W. B. | Manning, A. H. | Sutcliffe, J. G. |
| Ashmole, G. | Duxbury, H. | Moore, E. S. | Teasdale, C. E. |
| Barker, H. S. | Dyer, H. C. | Nice, A. J. N. | Theaker, A. D. |
| Barraclough, A. V. | Dyer, W. J. | Oxer, S. J. | Turnbull, H. |
| Barrett, A. | Foster, A. S. | Potts, P. C. | Watts, R. H. |
| Bleazey, E. W. | Horrocks, H. | Rees, C. | Wellbeloved, H. F. |
| Bradshaw, J. R. | Jones, I. J. | Rindle, C. | Wikner, S. A. |
| Braidwood, G. | Jones, W. G. | Rogers, R. E. | Williams, F. E. |
| Briggs, F. C. | Kitchen, J. E. | Rosney, W. | Woodward, H. |
| Brown, W. F. | Langford, C. G. | Ruggles, F. M. | Wrigley, H. |
| Cheal, A. G. | Lees, F. P. | Saville, T. W. | Wyatt, A. R. |
| Chester, R. P. | Linnell, G. T. | Seaton, A. J. | Wyver, C. |
| Croft, C. M. | Lord, C. | Seymour, C. C. | Young, R. F. |
| Dinford, A. | Luff, E. J. | Stapleton, C. | |

*Second Class.*

| | | | |
|---|---|---|---|
| Armstrong, P. T. | Dougall, P. | Lucas, H. | Scruton, A. G. |
| Badger, M. | Fenn, B. | M'Farlane, A. | Shepherd, D. |
| Batt, W. | Green, H. H. | McLeod, L. F. | Singleton, H. |
| Beard, W. C. | Greenwood, G. | Mason, W. J. | Skinner, F. N. |
| Bell, A. | Grice, A. E. | Melling, J. | Staley, R. |
| Brabbs, J. | Gulland, W. | Messenger, S. | Stone, H. E. |
| Brew, G. | Hartley, H. | Mitcheson, W. L. | Thorman, G. |
| Broadbent A. | Hamnett, A. J. | Monk, W. | Townley, W. |
| Broadbury, G. C. | Havey, R. B. | Newby, H. | Waldock, S. C. |
| Buckley, J. E. | Haydon, A. | Pettigrew, W. | Wates, S. B. |
| Burgoyne, J. S. | Haynes, G. H. | Pond, H. G. | Whitaker, J. |
| Burrow, E. G. | Hearmon, F. | Popham, F. J. W. | Whitcher, A. E. |
| Candy, H. E. L. | Hinchliffe, F. D. | Priestley, J. T. | White, O. |
| Carmichael, T. | Horsfield, H. | Reed, A. S. | Wild, W. |
| Clark, W. J. | Huntley, J. | Rice, G. H. | Wilkins, A. H. |
| Connolly, A. | Kendrick, A. | Robinson, A. | Wilkinson, G. H. |
| Cooper, J. F. | Lamb, G. H. | Rudge, C. A. | Winslow, G. |
| Cox, S. K. | Lamb, J. | Russ, S. | Woodroffe, G. F. |
| Craggs, E. F. | Littler, R. P. | Saunders, P. J. | Wren, L. C. |

## PLYMOUTH AND STONEHOUSE GAS COMPANY.

### Sir J. A. Bellamy on the Price of Coal.

Sir Joseph A. Bellamy, who presided at the annual meeting of the Plymouth and Stonehouse Gas Company last Thursday, in moving the adoption of the annual report (a summary of which appeared in the "JOURNAL" last week, p. 838), congratulated the shareholders upon the very satisfactory results achieved, in spite of the fact that in the past year coal and oil cost £5639 more than the year before.

This, Sir Joseph Bellamy said, was a very considerable sum to make up; but they had not been starving the works in other directions. A few years ago they debited the revenue account with £10,000 as the value of the old retort-house which was demolished on the erection of the new one. They paid off this sum last year, and the item had disappeared from the balance-sheet. They had, however, paid £3500 to the renewal fund account as usual. He referred last year to the big increase in the price of coal. This year there was a still greater increase, due to the abnormal demand from Germany and other places, and to the boom in industry in this country. The result of the increase in the price had been to drive the Company into other markets for coal. They had had to buy this year a very large proportion of their coming supplies from Yorkshire. He was not sure that the policy pursued by the Durham coalowners in demanding the very last penny from their old customers would prove to be wise. Until last year the Plymouth Gas Company had not concerned themselves about Yorkshire coal; but owing to the very high prices demanded by the Durham collieries, they had to look for other sources of supply, and they found Yorkshire coal satisfactory. He was not sure that it would not have been wise for the Durham coal owners to keep their old customers by a little present sacrifice, with a view to ulterior gain. They were, of course, justified in securing the higher prices; and what he said was not in the way of complaint. The Directors had been fortunate enough to secure 20,000 tons—a third of their supplies for the coming year—at a reasonable price, certainly less than they would have to pay now. There might be difficulties in regard to deliveries from the Yorkshire ports, in consequence of the very large supplies that the Yorkshire collieries would have to make this year. But they could not expect to get through a crisis like the present without trouble; and having regard to the men with whom they were doing business (both coalowners and shipowners) he had no doubt that they would get through the difficulty without loss to the Company. With reference to the electric light, though the output of gas continued to increase—it had been about 2 per cent. over the past year—there was no doubt that the competition of the electric light interfered with their progress; and from a calculation he had made, he believed that, but for the competition, they would be supplying gas at 1d. per 1000 cubic feet less to the gas consumers of Plymouth and Stonehouse. They could not help this; and he was not saying the electric light ought not to be there. But in view of the fact that they were working with the consumers of gas on partnership lines, under the sliding-scale, if the price were 1d. higher than it otherwise would be, nine-tenths of the extra price fell upon the consumers, and one-tenth on the shareholders. So when they saw congratulations sometimes as to the progress made by the Electricity Department of the town, it must be borne in mind that the gas consumers, which practically meant all ratepayers, were paying an extra price for their gas, because of this progress. As regarded the efficiency of one light compared with the other, they had a friendly battle last year at the Plymouth Exhibition; and he thought the Gas Company came out on top. At all events, the Committee of the Exhibition felt so satisfied with it that they had made a contract with them for the coming exhibition, by which they would light the exhibition exclusively with gas—electricity being put aside. Gas in Plymouth could be supplied equal in efficiency to the electric light, at a much less cost. That was the point they were going on. Their gas was cheap, and it enabled them to do things which could not be done, perhaps, in other towns. The cost of repairs at the works had been much less than last year. Very large sums were being saved through the improvement effected in regard to the stoppages in the mains and service-pipes. From very early times, this had been a great source of trouble to the Company, as it was to most other gas companies. The Directors went into the matter very seriously, determined, if possible, to find a remedy. They had at last achieved very considerable success. In 1904, they had 18,835 complaints respecting the choking of pipes; in 1905, they had 16,368; and in 1906, 6404. Two-thirds of the complaints had thus disappeared; and as in the past six months the number had been only 765, they had a further great reduction upon the comparatively small figures of last year. It had cost a little money on appliances and supervision to effect this; but the saving had been enormous in many respects. A very steady and prosperous business was being done in cooking-stoves; and it had been arranged that a system of prizes for gas-cooking should be established in connection with the schools of the town. The Company would give the prizes, and the Education Authority would allot them. The Company had a large *clientèle* among the artizan class; and anything they could do to encourage good cooking, it was their duty to do. As to the future, they were watching the Coalite development with the greatest attention. The process of carbonizing which was proposed as the means of making profit to that Company, suggested big possibilities for gas undertakings. If by carbonizing at a lower temperature and extracting a less quantity of gas something might be produced which was not coke but smokeless fuel—an article which could be sold to the householder at something less than the price of ordinary coal, and while it gave out a great amount of heat would maintain a lively fire—some gas companies were in an admirable position to supply the demand. By utilizing their present plant, or by remodelling it and putting up some small additions, most companies might carbonize a far larger quantity of coal than they were now doing, and produce instead of coke a fuel suitable for household use; while by selling the bye-products, they would make very large profits for the shareholders. He did not know how it might be elsewhere, but in places like Plymouth his opinion was that any demand there might be

for a fuel such as Coalite could be best supplied by a gas company. If patent rights existed, it would be necessary, of course, to pay a royalty; while if these rights did not exist, their Company might produce an article similar to Coalite without paying royalties. In any case, there was a prospect of a big future for gas undertakings; and he did not despair of a very much more satisfactory financial result and of a bigger dividend and a lower price of gas in Plymouth at no distant date. He was grateful to the officials for their cordial co-operation during another year. They had worked very harmoniously together. The men, too, had worked well and without friction. Such small grievances as arose from time to time had been settled in a very friendly way.

A few questions were put by shareholders; and, in reply, the Chairman said it was premature to express an opinion as to Coalite or any rival it might have. The Directors did not intend to jump into experiments. There were two sides to the matter; and it was better to proceed with caution. It had been suggested that instead of clay retorts cast-iron retorts could be used for the production of Coalite or Carbo; and if so, this would be an important element, because of the cheaper cost. The process of brickmaking adopted a few years ago was in a state of suspended animation. As regards their crushing strength, the bricks were very superior. Complaint had, however, been made of their use in a particular case—whether through insufficient care in their handling he could not say. Litigation was now pending, not between the Company and any buyer of bricks, but between other parties; and he preferred not to say anyhing on the matter at present. There was nothing serious as far as the Company were concerned.

The report was adopted, and the dividends recommended—6½ per cent. on the ordinary stock, 9s. 9d. per share on the additional shares, and 9s. 3d. per share on the new shares—were ordered to be paid.

## INSPECTION OF GAS LIQUOR AND OTHER WORKS UNDER THE ALKALI ACTS.

### District Inspectors' Reports.

We complete to-day our notice, commenced last week (p. 832), of the reports of the District Inspectors under the Alkali Acts, contained in the annual report of the Chief Inspector (Mr. R. Forbes Carpenter), which has already been dealt with.

In the East Midland district, which is under the supervision of Mr. E. Morley Fletcher, three new sulphate of ammonia works were started during the past year; two of them in connection with coke-oven works with recovery plant, and the other is at gas-works. The foul gases from the saturator in each case are absorbed in heaps of oxide of iron with hydraulic change-valves. These oxide heaps, in Mr. Fletcher's experience, give satisfactory results with ordinary care, and when they are properly designed. He considers the best form to be that laid on a concrete floor; the foul gas being conveyed underground to a pit, from 2 ft. 6 in. to 3 feet square, in the centre, covered by a grid, and the oxide being heaped round and over this. When the foul-gas main is above the flooring and the end turned up, the lower portion of the oxide is unused, and an unnecessarily large heap is needed. The best practice is to change over to a reserve heap every one or two days; the idle heap meanwhile being levelled and revivified where it lies, and afterwards raked up into a heap in its turn. This entails little labour, and is often attended to by the stillman himself. At one works in the district a Claus kiln has been erected for dealing with the sulphuretted hydrogen from the sulphate plant that formerly passed to oxide purifiers. The total quantity of ammoniacal products manufactured during the year, given in terms of sulphate of ammonia, was 19,080 tons; the proportion of sulphate and muriate of ammonia made by continuous processes being 98·8 per cent.

There are now 105 works registered in the South Midland district, which is under the supervision of Mr. Edward Jackson, where the manufacture of sulphate, muriate, or carbonate of ammonia, or the concentration of gas liquor, is carried on. Four new works for the manufacture of sulphate of ammonia were added to the register last year. At two of them, the plants are attached to gas-works; and Mr. Jackson says "The attention to detail, especially at one works, with a view to prevent all cause for complaint arising in the manufacture, was very praiseworthy." Both works have efficient condensers, and are provided with oxide purifiers, built with cavity walls—in one case filled in with cement, and in the other with pitch. At the larger works, two purifiers have been attached, to be worked alternately, with a hydraulic change-valve; but at the other smaller works, one purifier only is required.

The other two new sulphate of ammonia works registered are both in connection with coke-oven plants. In each case the saturator gases are returned to the gas plant, and after treatment there with gas liquor what remains is subsequently burnt—having thus been mixed with the gases used to heat the ovens and for steam raising. The increase shown in the total acidity, from numerous tests taken of the chimney gases, was not considered to be large enough to require other treatment of the sulphuretted hydrogen, no trace of which was found in the chimney gases. Coke ovens with recovery plants attached are now rapidly increasing in the district. Four additional plants, at least, are in course of erection; and others are under consideration. As yet these ovens have been erected mainly in the northern portion of the district—North Derbyshire and South Yorkshire: two installations only being in North Staffordshire. In Nottinghamshire, South Staffordshire, and in the coalfields of the adjoining counties of Warwickshire or Worcestershire none of these coke-ovens with bye-products recovery plants have been erected up to the present.

At three works where the sulphuretted hydrogen from the sulphate of ammoniate saturators is dealt with by combustion and arrest of the sulphurous acid in limestone and water towers, the plants were in operation as usual during the year without any important modification in the method of working. At one works, Mr. Jackson discovered a

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very excessive escape of acid from the final tower; and had it not been for the examination by quantitative testing (previously emphasized as necessary in this operation), the escape could have gone on unchecked for some time without discovery. No further extension of this combustion-neutralizing process has to be reported in the district. Legal proceedings had to be taken in respect of two works during the year for infractions under section 9 of the Act of 1881—in both instances for escapes of sulphuretted hydrogen from sulphate of ammonia plants through the use of faulty condensers and neglect of the oxide of iron purifiers. Similar escapes had been previously reported, and several warnings given. The maximum penalty under the section was paid. The total bulk of liquor distilled, expressed as sulphate of ammonia, was 39,106 tons; 99 3 per cent. being by the continuous process.

In the South-West of England and South Wales, Dr. Alfred C. Fryer has 166 works and 201 processes under his supervision; 83 processes being connected with the manufacture of sulphate and muriate of ammonia. The total quantity of ammoniacal compounds produced during the past year amounted to 12,695 tons, calculated as sulphate of ammonia; and the proportion of liquor distilled by the continuous process was 89·5 per cent. Six new sulphate of ammonia plants were registered during the year; and they are all provided with good condensers and oxide of iron purifiers. The old intermittent method of distillation has been abandoned at two works; continuous stills with good condensers and ample purifiers having been erected. At one works the purifier has been enlarged, so that there is now 96 cubic feet of oxide of iron employed per ton of sulphate of ammonia made per week. The disposal of sulphuretted hydrogen by combustion and subsequent neutralization of the acid products is in use at only one works. Several oxide of iron purifiers were tested at the time the sulphate plants were in operation, in order to ascertain if any hydrocyanic acid gas was passing through them. In only one case was any trace of this poisonous gas detected, and that was at a plant which was not working in its normal condition. The water supply had been suddenly cut off, and consequently the condenser was not doing its duty, and the oxide of iron was steaming. Dr. Fryer points out that the year's returns show that the sulphate of ammonia made at the coke-oven bye-products plants last year was more than double that produced in 1905.

In Mr. F. Napier Sutton's district, covering the eastern and south-eastern counties, there were under inspection last year 94 processes connected with the manufacture of sulphate of ammonia. Four new works were registered—one for treating gas liquors and three for the making of sulphate. The total quantity of ammoniacal compounds manufactured in the district was 48,109 tons, expressed in terms of sulphate; showing a slight increase on the production of the previous year. The proportion of liquor distilled by the continuous process was 99·1 per cent. As is well known, the products manufactured from gas liquor consist chiefly of sulphate of ammonia; but they include carbonate and nitrate of, as well as liquid (concentrated and refined) and anhydrous, ammonia. All the products were obtained from the carbonization of coal, with the exception of a few hundred tons derived from the treatment of bone in the manufacture of animal charcoal. The gas-works belonging to companies and local authorities produced 88·6 per cent. of the products; and the balance of 11·4 per cent. was made in the works of private firms.

Recovery as sulphur by the Claus process of limited oxidation accounts for more than 12 per cent. of the sulphuretted hydrogen evolved; and the sulphur so recovered is used either for acid making or for the recovery of cyanogen compounds, and thus the full market value of this residual is obtained. The eight units of plant at work in the district have all been maintained in very sound and satisfactory condition; and careful work has resulted in increased yield of sulphur in several cases. Disposal of the foul saturator gases by absorption in oxide of iron purifiers is in use at 66 works in the district, and accounts for 9·4 per cent. of the whole. Mr. Sutton says this method of disposal remains undoubtedly the best where the make of sulphate is small. The use of heap purifiers has been further extended; and this form of purification continues to find great favour wherever it is adopted.

The number or works at which the saturator gases are treated by the combustion neutralization method has been reduced to eight, as at one works the manufacture of sulphate has been discarded in favour of making concentrated ammoniacal liquor in which the sulphur compounds are retained. The proportion of foul gas treated at the eight works using the method is 7·4 per cent.; and, for the reason above given, it is somewhat less than the previous year. The plants in use and the working results are in six cases satisfactory; but at the other two consistently good results are not yet obtainable. The presence of any trace of ammonia in the saturator gases immediately affects their combustibility. A marked instance of this occurred at one works where usually the gases burn freely with the aid of a pilot-jet of coal gas. The foul gases suddenly failed to ignite, and were with difficulty made to burn, even when a large coke fire had been placed in the base of the combustion chamber. No ammonia could be detected in the gases leaving the saturator. But ammonia was present when they entered the furnace; and investigation led to the discovery that the tubes of the liquor-heater were defective.

Reference was made in the last report to trouble experienced at two works through opposition on the part of local authorities to the admission of spent liquors to the sewers. In both cases the Radcliff process for precipitation of the sulphocyanides has been adopted, and Mr. Sutton reports that no difficulty has since arisen. There was no complaint last year of nuisance or damage arising from any works in which gas liquor was treated.

Late last year the distillation of tar was resumed at works where this operation had been discarded for some years; and the works at which distillation plant is in use now number 20. Their distilling capacity varies greatly, for at one works only a single 5-ton still is employed, and at another 48 stills of 10 tons capacity are in use. On the other hand, one of the patent continuous stills has a daily capacity of 25,000 gallons of tar, and has been in absolutely continuous operation for more than eight months. Provision exists in all cases for dealing with the permanent noxious gases evolved at the worm-end, and these are either conveyed to a fire for destruction or are absorbed in oxide or

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lime purifiers; but the former plan is in more general use in this district. An effective water-seal between the receiver and the fire is very necessary; and the absence of such a safeguard resulted in a serious, but fortunately harmless, explosion at one works. The proprietors have since adopted lime purification in preference to the combustion method of disposal.

The total distillation plant employed in the district amounts to 114 intermittent pot stills and three Lennard's continuous stills.

The details of the work done in Scotland are presented, as usual, in a report made to the Chief Inspector by Mr. W. S. Curphey, F.I.C., F.C.S. The number of registered works in which sulphate, chloride, or hydrate of ammonia was made during 1906 was 84; being seven more than in 1905. These works comprised 16 iron-works, 13 shale-works, 8 coke, producer-gas, or carbonizing works, and 47 gas-liquor works. The quantity of salts of ammonia made (expressed as tons of sulphate) was as follows: Gas-liquor works, 18,287; iron-works, 20,204; shale-works, 48,534; producer-gas, coke, and carbonizing works, 11,220—total, 98,245 tons, compared with 91,028 tons in 1905. The practice of dealing with gas liquor at the place where it is produced continues to extend; and each year brings an addition to the number of gas-works where plant for the manufacture of sulphate of ammonia is in use. In this way, an increase in the number of works arises, but does not necessarily indicate increased activity in production. The figures given above show a moderate increase in the production in iron, shale, and gas-liquor works—an indication that these industries increased in activity during the year. In the group included under "producer-gas, coke, and carbonizing works," there was an increase of 4083 tons, or fully 57 per cent. more than in 1905. Mr. Curphey says this increase is due to the extended adoption of recovery plant in coke and producer-gas works; and he thinks it is probable that a still further expansion of production of sulphate of ammonia from this class of works will occur.

The use of the vacuum method of distilling ammoniacal liquors continues to extend slowly in Scotland. This method is in active operation in two works; and the necessary plant is about to be erected in a third. Another application of the vacuum method is in the evaporation of the sulphate of ammonia liquors obtained when removing ammonia from Mond gas. By its use the escape of large volumes of steam is prevented; while it is claimed that a saving in fuel is effected. No new methods have been introduced for dealing with the sulphuretted hydrogen in the waste gases arising from the treatment of ammoniacal liquor. Mr. Curphey says the presence of cyanides, especially in the ammoniacal liquors in coke-oven works, to which attention has been directed in previous reports of the Chief Inspector, calls for the most serious consideration from the owners of these works.

The number of registered works in which tar was distilled during 1906 was 40—a reduction of one from 1905. Distillation was stopped in three works, while it was started in two others. Lime purifiers are still the means in general use for dealing with the waste gases produced during the process of distillation. No change took place in this class of works during the year.

## MALTA AND MEDITERRANEAN GAS COMPANY, LIMITED.

The Ordinary General Meeting of this Company was held last Tuesday, at the London Offices, No. 63, Gracechurch Street, E.C.—Colonel JAMES LE GEYT DANIELL in the chair.

The SECRETARY (Mr. A. W. Cooper) having read the notice convening the meeting and the certificate of the Auditors, the Directors' report and the statement of accounts were taken as read.

The CHAIRMAN said the Directors met the shareholders with some feelings of satisfaction, having regard to the report they were able to make of the operations of the Company during the year to March 31 last. It would be seen that coal, oil, &c., had cost £11,353, as against £10,229 the previous year, which was an increase of £1125, or 10·99 per cent.; but they had carbonized 1512 tons more. The cost of the coal worked out at about 17s. 5d. per ton, against 16s. 11d. The quantity of coal carbonized was 11,341 tons, compared with 9829 tons; and of oil used, 69,200 gallons, as compared with 97,780 gallons. The figures under the heads of coal, &c., gas making (salaries and wages), charges on street lights, maintenance, purifying materials, rates and taxes, and general trade charges, amounted to £23,784, against £22,491; but it had to be remembered that this included the £1125 extra for coal. Turning to the other side of the profit and loss account, it would be noticed that the receipts for gas (£31,171, against £29,333) showed an increase of £1838, which was equal to 6·26 per cent. Coke also had brought in £1326 more; but tar and pitch exhibited a slight reduction. There was a small increase on fittings account of £268. The total receipts were £40,378, against £37,047; the balance of profit carried to the general revenue account being £14,485. Coming to this account, he might point out that interest on debentures figured at somewhat less, as during the twelve months they had paid off £1000 of debentures. The Chairman who addressed the shareholders ten years ago—in 1897—remarked that the debenture debt was £39,700; but since that date, the Board had paid off £25,200, which left a balance of £14,500. They had also added this year £6000 to the amortizement account, which the general balance-sheet showed now stood at £26,597. Sundry debtors had somewhat increased (being £1791 more), and they would no doubt continue to do so from time to time, particularly as business grew. The increase was really due to municipal arrears at the Sicilian stations, which, however, had been, and were being, looked up with commendable activity. Under the head of investments, they had written off £577. Notwithstanding this, it was pleasant to see that the net balance compared favourably with the preceding year—being £6134, as against £5677. Taking the stations in detail, he might say that from Malta there was nothing but good to report. The consumption both by private consumers and in the public lighting had increased. As to the naval establishment, which twelve months ago he drew attention to, and said the Company must be prepared for a falling off there, because the authorities were preparing for an electrical installation, he was pleased now to say that

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he was wrong, because the consumption had again rather increased. But the electrical works had not been finished quite so soon as the Board had anticipated; and he thought the Company would now feel the effect of it. The military consumption had increased 5·65 per cent.; and negotiations were going on which led the Directors to hope that the additional gas supply to these barracks, and the increased consumption in other directions, would make up for any loss they might experience in connection with the naval establishments. At Malta, there appeared to be a growing demand for cookers also. It was a small place, of course; and therefore he thought that 706 was not an insignificant number to have in use. They had increased somewhat lately; and the fact that in the year under review the Company had laid 268 new services and connected 322 old ones, was an indication that the public found they could get, by means of incandescent burners, a cheaper and more agreeable light than any other they could obtain. While on this subject, he must express his appreciation, and the appreciation of his colleagues on the Board, of the assiduity in the performance of their duties of the various officers, all of whom gave the greatest possible satisfaction. They were keen and active in business, and had enabled the Company, not only to hold their own, but to put the electric light in a second place—though they could not unfortunately put it out. As to Trapani, not much progress had been made with the question of the Municipality taking over the works. A year ago he mentioned that the Board had availed themselves of the services of Signor De Colo Proto, who was an advocate of some eminence. He had been able to hold his own with the municipal lawyers, and to arrange with them as to what questions were to come forward for arbitration. The other side wanted to have it all their own way; but Signor De Colo Proto, being conversant with all these matters, very soon got his views accepted. He (the Chairman) thought that, if anything at all was done, they would very soon discover the advantages of this. These Sicilian stations were more or less an anxiety, and were not of very great profit to the Company. Twelve months ago, he said that the next year would be their last at Marsala; but it was not. The contract came to an end; but negotiations had been entered into, and it had now been decided that they should work on the old basis for two years more. He very much questioned whether the authorities would be ready at the end of this period. The Chairman concluded by moving the adoption of the report and balance-sheet.

Mr. A. M. PADDON seconded the resolution, which was carried unanimously.

On the proposition of the CHAIRMAN, seconded by Mr. A. F. PHILLIPS, dividends were declared for the year ending March 31, at the rate of 7 per cent. per annum on the first preference shares, 7½ per cent. on the second preference shares, and 5 per cent. on the ordinary shares—deducting the payments already made on account.

Proposed by the CHAIRMAN, and seconded by Mr. PADDON, the retiring Director (Mr. A. F. Phillips) was re-elected; and the Auditors (Mr. R. Hesketh Jones and Mr. Thomas Guyatt) were re-appointed, on the motion of Mr. JOSEPH CASH, seconded by Mr. W. H. DAUN.

The CHAIRMAN said he had already referred to the work of the officers of the Company; and he now wished to move a vote of thanks to them. They deserved it; and he knew the value they placed on any expression by the shareholders of satisfaction at the services they rendered to the Company. Mr. A. W. Cooper had all the reins in his hands; and he put him, as Secretary, at the head of the list. Then there were Mr. J. W. Starkey, the General Manager, Mr. Robert Wilson, the Engineer, and Mr. W. A. Reid, the District Superintendent, who were doing their utmost for the Company in Malta. He must also include the Managers at the Sicilian stations—Mr. Marino at Trapani, and Mr. Torrini at Marsala.

Mr. PHILLIPS, in seconding, remarked that he could more than endorse all the Chairman had said regarding the services rendered by the staff, both abroad and in London. As to Malta, he had gone through the accounts very carefully; and he could assure the proprietors that the results of the past year exceeded those previously attained—whether it was in the production of gas, in the economy of fuel, or in the expansion of the Company's business. They were extending in Malta very satisfactorily; and this was due to the energy displayed by the officers. In Sicily, of course, the officials had great difficulties to contend with. It was more a matter of fighting the authorities than of manufacturing gas; and the continual annoyances they suffered very much embarrassed them. It could only be hoped that the difficulties in Trapani would be overcome, and that in Marsala they would be able to satisfactorily dispose of their business.

The proposition was agreed to; and Mr. COOPER returned thanks.

Mr. CASH, in proposing a vote of thanks to the Chairman and Directors, congratulated them on having issued the most prosperous set of accounts he had ever seen presented in connection with the Company. He was very pleased to see the Board were taking care of the amortization fund. This was most important, taking into consideration the position the Company occupied with regard to their Sicilian stations.

Mr. GUYATT seconded the motion, which was carried; and the CHAIRMAN acknowledged the compliment.

## STREET GAS LIGHTING IN BERMONDSEY.

At the Meeting of the Bermondsey Borough Council last Tuesday, the Street Lighting Committee reported having received a report from the Borough Surveyor with reference to the cost of the conversion of the flat-flame gas-burners throughout the borough to the incandescent system. In this report he stated that the cost originally suggested by the Gas Company would have been £937 (937 lamps at £1 each). This would have entailed a higher consumption of gas with only a very slight increase of candle power. By the method he suggested, which included the climbing-light apparatus, and the altering of lamps for them, the cost was estimated at £885 0s. 3d. (973 lamps at 18s. 3d.


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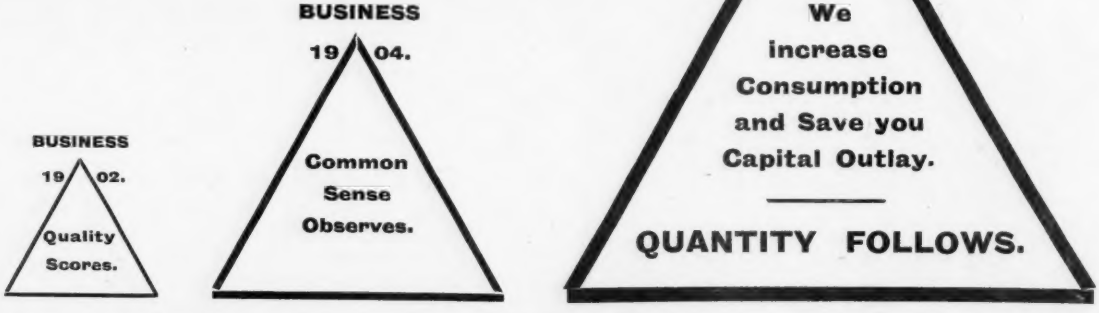


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each). The same results had been arrived at by dispensing with the climbing-light apparatus after a short trial; and the necessity of altering the lamps had been obviated by the introduction of a ball-bearing anti-vibrating "C" incandescent burner without either bye-pass or climbing-light apparatus, at a cost of £480 15s. 4d., made up as follows: 150 burners and fixings purchased during 1905-6, £72 18s. 4d.; 837 lamps converted, including burners, all fittings, and labour, £407 17s. —showing a saving to the borough as compared with the Gas Company's estimate of £456 4s. 8d. By abolishing the bye-pass and using the flash-torch, a saving of £156 3s. 4d., or 3s. 4d. per lamp, was effected. In a further report, the Surveyor stated that there were 1529 lamps lit by gas in the borough, as compared with 2051 previous to the electric undertaking coming into force. The following table shows the description, candle-power, capacity, and cost of each kind of lamp at present in use in the borough.

| Description of Burner. | Candle Power. | Amount of Gas burnt per Hour. Cubic Feet. | Number of Lamps in Use. | Cost of Gas per Lamp per Annum net, at 2s. per 1000 cubic feet (less 5 per cent discount). | Cost of Maintenance, &c., per Lamp, per Annum, Net. | Total Cost of Lamps per Annum, Net. |
|---|---|---|---|---|---|---|
| | | | | £ s. d. | £ s. d. | £ s. d. |
| No. 2 Kern . | 50 | 2¾ | 44 | 0 19 2 | 1 0 5 | 1 19 7 |
| No. 3 Kern . | 70 to 75 | 3½ | 289 | 1 7 2 | 1 0 6½ | 2 7 8½ |
| No. 4 Kern . | 100 | 4½ | 144 | 1 16 11 | 1 0 1 | 2 17 0 |
| C. Incandescent | 70 to 75 | 3½ | 1015 | 1 6 7 | 0 18 6 | 2 5 1 |
| Centre Lights (Clusters of Burners). . | .. | .. | 11 | various charges. | .. | .. |
| High Pressure | 375 | 10 | 26 | 7 2 6* | .. | 7 2 6 |
| 5 ft. Flat Flames, now out of use . | | | | 1 16 4 | 0 15 1 | 2 11 5 |
| Total No. of Lamps . . | | | 1529 | | | |

* Including maintenance.

**Exmouth Water Supply.**—An inquiry was held at Exmouth last Tuesday by Mr. Brightman, an Inspector of the Local Government Board, with reference to an application by the District Council for a loan of £6663 for the improvement of the water supply. It is proposed to spend £5763 in the purchase of land and the construction of high-level filter-beds, a storage reservoir, and a meter-house. The balance of £900 will be laid out in the purchase of 56 acres of common land just above the proposed reservoir. The Surveyor explained that there will be three filter-beds and a storage reservoir with a capacity of 184,000 gallons. The present storage is only 156,000 gallons, or about eight hours maximum demand; and owing to the absence of filter-beds at the higher level, some of the houses are supplied with unfiltered water, or with water at a very low pressure.

## LIGHTING AND WATER SUPPLY IN RHYMNEY VALLEY

### Proposed Acquisition of Undertakings by Local Authorities.

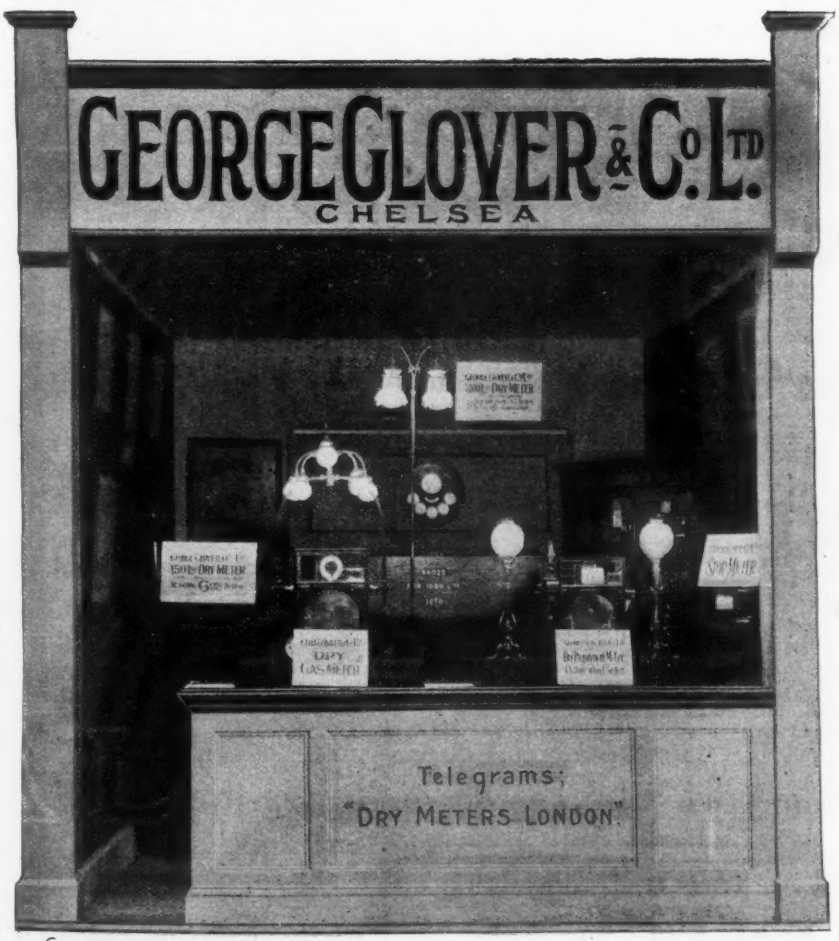
Last Wednesday, a Conference was opened, at the Council Offices, Caerphilly, of representatives of Local Authorities in the Rhymney Valley, to consider the advisability of acquiring the business and works of the Rhymney and Aber Valleys Gas and Water Company and of other Companies in the district. Mr. J. HOWELLS, J.P. (Caerphilly), was selected as Chairman; and Mr. W. SPICKETT was appointed Clerk to the Conference.

The CLERK opened the proceedings by presenting a return showing the rateable value, &c., of each district within the area of supply of the Rhymney Company, as follows:—

| Name of Council. | Population. | No. of Houses. | Rateable Value. |
|---|---|---|---|
| Caerphilly . . . . . | 18,060 | 3440 | £89,064 |
| Gelligaer . . . . . | 22,302 | 4248 | £120,000 |
| Bedwellty . . . . . | 13,500 | 1000 | £10,000 |
| Mynyddislwyn . . . | 1,040 | 208 | £2,286 |
| Rhymney . . . . . | 9,600 | 1917 | £27,266 |
| St. Mellons . . . . | 1,200 | 200 | £1,600 |

The CHAIRMAN, introducing the subject, remarked that everything that was for the health of the people should be in the hands of the local authorities; and it was useless to hope that good sanitary conditions could be brought about unless a constant supply of water was given, and unless the supply was in the hands of the people governing the district. The Rhymney and Aber Valleys Gas and Water Company had an excellent gathering-ground at the other end of the Valley; but they had failed to give a proper supply of water, and this difficulty was greater at Caerphilly than anywhere else. He thought, therefore, that the authorities should join and take over the concern. He had heard from a reliable source that the Company would be quite prepared to sell their undertaking to the Local Authorities. The supply of water was now very unsatisfactory; the quantity being short in dry weather, and the quality bad. So far as the Company's gas undertaking went, they were now effecting considerable improvements at Caerphilly and elsewhere; but he thought it would be very important that the authorities should have control of the lighting as well as the water. At Caerphilly, they had made all necessary arrangements for having the district supplied with electricity; but, unfortunately, the Company with whom they had arranged to supply the power had got into difficulties, and it seemed very doubtful whether they would carry out the work for a considerable time. Personally, his views were that they should go in jointly and take over the powers of the Company, and see if some reforms could not be brought about.

Mr. W. S. NASH (Mynyddislwyn) said he heartily endorsed the remarks of the Chairman; and, with the view to bringing matters to a satisfactory solution, he moved that the representatives should take back to their several authorities a recommendation that an expert should be engaged to report upon the whole scheme—water supply,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rateable value, population, &c.—and let them know whether or not it would be possible to purchase the works. The cost would be borne by the authorities in proportion to the rateable value of the districts.

Mr. W. HAMMONDS (Gelligaer) thought they should separate the gas from the water question. At the present time a certain Syndicate had powers to supply electric light throughout the Valley. If this came about, the gas undertaking would become a burden to the Local Authorities, and the ratepayers would suffer.

Mr. D. PHILLIPS (Bedwellty) asked whether it was the intention to buy out the New Tredegar Gas and Water Company as well as the Rhymney Company.

Mr. W. S. NASH (Mynyddislwyn) said he did not understand it to be so. He took it they were to acquire the Rhymney and Aber Valleys Company, and to carry on the undertaking.

Mr. J. AURELIUS (Gelligaer) thought it would not be right unless the whole area was taken up. A portion of the Gelligaer district was supplied by the New Tredegar Company; and unless this concern was acquired, the ratepayers in the area would have to take just what the Company wished to give them.

Mr. F. T. JAMES, the Clerk to the Gelligaer Rural District Council, replying to Mr. Nash, said there was a clause in the Act of Parliament by which the New Tredegar Company could tap the mains of the Rhymney Company at a given point; but there was no obligation upon them to take water from the Company. It was reasonable to think that the New Tredegar Company would not purchase water so long as their own sources of supply kept good.

Mr. A. THOMAS (New Tredegar) said the Company at his place were laying down the mains to make a junction with those of the Rhymney Company. There was one difficulty, however, if the Rhymney Company sold a great deal of their water they might find themselves without sufficient for their district. If they were going to try to get the water back into the people's hands so far as the Rhymney and Aber Valley Company were concerned, it should also be for the New Tredegar Company's area.

After some further remarks, it was decided that all the works in the valleys should be taken over.

Mr. JAMES pointed out that it would be necessary to have two engineers—one for the gas and the other for the water undertaking.

Mr. HAMMONDS thought the gas section would not be a beneficial one.

The CHAIRMAN said that according to the Company's balance-sheet the water supply was the paying portion of the Company's business; and they could hardly expect them to dispose of one without the other. A few years ago, the Caerphilly Council had presented to them a report upon the Company's supply. They possessed an excellent gathering-ground, which could be made ample for the district.

Mr. W. THOMAS said that the report provided for a consumption of 15 gallons per head per day; and upon this they would require a storage of 305 million gallons for a population of 155,000, and for a consumption of 20 gallons per head per day, 320 million gallons. This would provide for a drought of 130 days. In North Wales, the average duration of a drought was 90 days; and in Lancashire and Yorkshire, 160 days. The expert therefore based South Wales on 130 days' drought; and for the population of 155,000, storage would be required for 305 million gallons. These figures had been given to them also from another source; so they had practically two independent reports from different gentlemen.

Finally, the recommendation to go to the Councils for instructions to engage an expert was adopted; and the meeting was adjourned till the 18th prox.

## GOOD REPORT AT KENDAL.

Satisfaction with the past year's results (which he said were much better than had been anticipated) was expressed by Alderman Monkhouse when proposing the confirmation by the Kendal Town Council of the minutes of the Gas and Water Committee, which included the report of the Manager.

Explaining the position of affairs, Alderman Monkhouse pointed out that the make of gas had considerably increased—from 79 million cubic feet to 83 millions. The receipts were proportionately larger, and the expenditure also; the net result being a gross profit of £4091, which was a record since they acquired the works. When they took into account the great reduction in the price of gas from 3s. 6d. to 2s. 8d. per 1000 cubic feet, and the abolition of meter-rents, which on an average would be a loss of fully £500 per year, the result was excellent. Looking back to 1896, the first complete year of the working in the hands of the Corporation, he found there were 1336 ordinary customers and 219 prepayment meter users. There were now 1802 ordinary and 1452 prepayment meter consumers. Out of the gross profit of £4091, interest on debentures absorbed £2032 (less £183, being interest from bank and on reserve fund investments) and the sinking fund £899, leaving a surplus of £1340, which he claimed to be a record profit, considering the reduced price of gas. They could really compliment the Manager upon handing over such an excellent surplus. They had promised £600 towards the rates. Then they had spent £158 on capital account, and proposed to pay this out of the surplus profit. The Gas Committee had a strong desire that, as far as possible, the capital account should be closed, and that they should pay as much as they could out of their revenue. The balance the Committee recommended should be carried forward to next year's account. They had to face this year an unforeseen circumstance—a considerable increase in the coal bill. They had had to enter into contracts which raised the cost 2s. 6d. per ton, which meant they would have £935 more to pay for coal during the coming year than they paid last year; but he was happy to say they had a little asset in hand on unexhausted contracts, by which they would benefit to the extent of £207, which reduced the increase to £728. Considering the balance to be carried forward, he had no hesitation whatever in saying, in spite of any fears which might

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have been expressed in consequence of the increased price of coal, that he saw no difficulty in promising to give the Corporation towards the rates at least £600 during the coming year. Another item which they had had to contend with, and over which neither the Council nor the Committee had any control at present, was the new assessment of the works, which made a difference of about £160 more than the previous year. Residuals had done exceedingly well; and by improved methods of working, they were making more money. In 1896, the first year, they obtained 6s. 9·5d. per ton of coal carbonized; last year it was 9s. 1·64d.—leaving the net cost of coal 5s. 8·88d. The sale of gas had increased by 70 per cent. since 1896; and the price had been reduced from 3s. 6d. to 2s. 8d. If there had not been the increase in the price of coal, there was no reason why gas should not have been sold at a less price.

Referring to the resignation of the Manager (Mr. W. Thomson), Alderman Monkhouse said if Mr. Thomson did as well for Ramsgate as he had done for Kendal, the Ramsgate people would never regret having engaged him; for he had done exceedingly well for Kendal, and on behalf of the Committee and himself he wished him God-speed in his new undertaking. They had appointed a fresh Manager. There were 88 applicants; the number being reduced to five, who came before the Committee. After careful consideration, they appointed Mr. Walter Wilson, who was not a stranger to them, because he had served his time with Mr. Ritson, and was an excellent servant while there. Mr. Wilson had gained considerable experience since; and they hoped, and fully believed, he would do as well for Kendal as Mr. Thomson and Mr. Ritson had done. If so, the Corporation would have no reason to regret the appointment.

## CHARGES FOR WATER IN LONDON.

At the Meeting of the Metropolitan Water Board last Friday the Law and Parliamentary Committee recommended a renewal of authority to them to negotiate with opponents of, and petitioners against, and to agree to such alterations and amendments in, the Board's Charges and Various Powers Bills as might be considered in the interests of the Board. To this, an amendment was moved by Mr. Walter Emden that it be an instruction to the Committee that the third reading of the Charges Bill be not proceeded with until a report of the precise effect of the proposed scale of charges on consumers within and outside the Administrative County of London had been considered by the Board. Mr. Emden said that when the Board had the Bill under discussion there was nothing before them to indicate, as had been disclosed by the evidence given before the Parliamentary Committee, that Inner London was to pay an extra amount to benefit the consumers in Outer London. Evidence had been given to show that the existing charge for water in Inner London was 6s. 3d., as against 4s. 1d. in the outer area; and now it was proposed to reduce the 4s. 1d. to 3s. 7d. at the cost of Inner London. The London County Council calculated the total loss to Inner London at £66,000, which capitalized meant that Inner London was to pay £2,200,000 for the benefit of Outer London, though at present it was paying what amounted to the interest on £5,000,000 in the reduction of the rate of Outer London. Mr. Dove seconded the amendment. Mr. Karslake, Chairman of the Law and Parliamentary Committee, said the Bill had been fully discussed by the Board in July and October last, with the result that they had eventually unanimously approved of its principle. It had been endorsed by the Parliamentary Joint Committee; and the object of bringing the matter before the Board now was to wreck the Bill. He appealed to the Board not to debate the question, as the arguments used would be employed against them elsewhere. After a long discussion, the amendment was defeated by 31 votes to 24; and the Law and Parliamentary Committee were given the powers asked for.

At the meeting of the London County Council to-day, the Parliamentary Committee will present a long report on the subject of the Bill above referred to. The Committee point out that by the proposed uniform charge the extra-London district will gain about £40,000 a year, even if no alteration is made in the basis of charge by the substitution of rateable for annual value; and they recommend that they should be authorized to endeavour to secure an amendment of the Bill, to provide that annual value shall continue to be the basis of charge for water in the outside districts.

## DERWENT VALLEY WATER SCHEME.

### Completion of the First Stage.

In commemoration of the completion of the first stage of the Derwent Valley water scheme, in which, as our readers may remember, the Corporations of Derby, Leicester, Nottingham, and Sheffield are concerned, "record" stones were laid last Friday, in the presence of a large gathering, representative of the towns interested. The works are being carried out by the Derwent Valley Water Board, of which Alderman Gainsford (the Chairman of the Water Committee of the Sheffield Corporation) is Chairman; and all the members, with the exception of Sir Henry Bemrose, who represents Derby, and is the Hon. Treasurer of the Board, attended the ceremony, in the company of about 140 guests, including the Lord Mayor of Sheffield, the Mayors of Derby, Leicester, and Nottingham, the Bishops of Southwell and Sheffield, the Rev. W. E. Rouse (Derwent), and the Rev. W. Gell (Pontefract).

The guests travelled by special trains to Bamford, whence they were carried on the private line of the Board, by way of Yorkshire Bridge and Ashopton, to the point in the valley where the great wall of the Derwent dam is being raised. On arriving at Derwent, Alderman Gainsford briefly welcomed the guests; after which the Engineer of the Board (Mr. E. Sandeman, M.Inst.C.E.) placed in the wall of the


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dam, under a record stone, a jar containing copies of the newspapers of the day and a sealed history of the Board, followed by a list of its members and officers. Sir Edward Wood (the Mayor of Leicester), the Vice-Chairman of the Board, then asked the Chairman to lay the record stone, and in doing so testified to the ability with which he had presided over their deliberations, and to the great progress made with the works under his directions. Mr. Sandeman having presented to Alderman Gainsford a handsome silver trowel and mallet, the great block of granite forming the record stone was swung into position, and was duly laid. The inscription on the stone was as follows: "Glory to God in the Highest. In the years of Our Lord 1902-19—, this Derwent Reservoir was built by the Derwent Valley Water Board, for the use of the people of Derby, Leicester, Nottingham, Sheffield, and Derbyshire."

Alderman Gainsford said he hoped the company would agree with him that it was fitting and right that they should put upon the works such a record as they had seen engraved upon the stone just laid. It indicated that the works had not been constructed for any private profit, but had been built by the people through their elected representatives, and for the use and benefit of the people. He paid a hearty tribute to the Engineer, the designer and constructor of the works, who entirely agreed with him in the simplicity of the record. He very heartily appreciated the gift of the mallet and trowel he had received. Mr. Sandeman would, he was sure, in the future take a leading place among engineers; and he would be fitted for it in every respect. In that future no one wished him success in his career more heartily than he and the Derwent Valley Water Board.

At the conclusion of the ceremony, the company moved up the valley to Howden, where another record was deposited and a stone laid by Alderman Gainsford.

The guests were then taken back by the trains to Birchinlee—the little village midway between the two dams which houses the small army of workmen engaged upon the undertaking—where luncheon was served in the recreation-room, Alderman Gainsford presiding.

After the meal, Sir Edward Wood took the opportunity of presenting to the Chairman a beautifully illuminated album, to mark the occasion of the laying of the stones. It comprised an address, photographs of the members of the Board and of past and present officials, and views of the works in course of construction. It was elaborately bound in the finest Levant morocco, with gilt edges, and had the Chairman's crest and coat-of-arms stamped in gold on the face of the cover. In making the presentation, Sir Edward spoke of the general feeling of confidence and esteem entertained by them, as members of the Board, for their Chairman. Alderman Gainsford, in acknowledging the presentation, referred to the fact that he had now been attempting to serve the public for something like 33 years, and said there was nothing in such service that one could look forward to as being more desirable than the kindliness and affection of those with whom one worked. He expressed his satisfaction at the presence of Sir John Brunner, the father of the Board, at that day's ceremony, and at the cordial relations existing between the members, as well as between the staff and himself. The toast of "The Engineer of the Works" was proposed by the Lord Mayor of Sheffield and duly honoured. In acknowledging it, Mr. Sandeman said that, unless something unforeseen occurred, the works would be finished within the estimate of their cost, and within a year of the time stated for their completion. "The Visitors," proposed by Sir William Clegg, was responded to by the Mayors of Nottingham and Derby; and "The Chairman," proposed by the Lord Mayor of Sheffield, was acknowledged by Alderman Gainsford, who said he expected the works would be completed in two years and a half. He added that he hoped later in the summer to invite the members of the Sheffield Corporation and their ladies to see the progress made with the scheme.

## SHEFFIELD CORPORATION WATER DEPARTMENT.

### The Past Year's Working.

At the Meeting of the Sheffield City Council last Wednesday week, the minutes presented by the Water Committee included the statement of the accounts, covering the twelve months ending the 25th of March last. They showed that the total capital expenditure to date had been £3,376,914; that the income for the year was £161,333; the expenditure, £35,614; the net revenue, £125,719. This was subject to the charges for interest and annuities, amounting to £107,311; leaving a net profit of £18,408. Deducting the annual instalment set aside out of revenue for the redemption of annuities and the extinction of loan indebtedness (£12,365), there was a surplus of £6043; being an increase of £7302 compared with the year 1905-6. The revenue account for the year 1905-6, however, contained a payment of £7091 to the River Don millowners and the Sheffield and South Yorkshire Navigation Company. Deducting this sum and the increased interest and sinking fund charges from the increase of gross profits shown by the accounts (£14,145), there was left a balance of £210 as the net increase on the trading compared with the preceding year. The accumulated surplus amounted on March 25, 1906, to £132,666. Adding the interest and the surplus for the year (together, £9342) brought this up to £142,008. But the Health Committee had been supplied without charge with water valued at £3313; so that the surplus at the close of the financial year was £138,695.

In a report accompanying the accounts, the General Manager (Mr. William Terrey) stated that the quantity of water delivered throughout the district during the year, including the statutary compensation water sent into the Rivers Rivelin, Loxley, and Little Don, was 9,461,388,624 gallons; the average daily supply being 25,921,613 gallons. The supply by meter was at the rate of 16·17 gallons per head per day; the domestic and other supplies (including water used at fires and waste) being at the rate of 11·73 gallons—making a total of 27·90 gallons. These figures are based on the total town supply—viz., 4,882,711,405 gallons. The report concluded with an account of the progress of the various works.

In presenting the minutes, the Chairman of the Water Committee


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(Alderman Gainsford) remarked that though they were better than last year by only the small sum of £210, they were better by £8000 than they had expected to be in their estimate. This sum had come to them for three reasons. In the first place, the income had been £4342 more than they had anticipated; this being due to prosperity in the trades of the city. In the second place, the administrative expenditure had been reduced by £2525. This was quite exceptional, and arose through the reduction in the rates. The third reason was that the amount of capital expenditure had been £30,000 lower than was expected. Less work had been done; and the rate of interest charged on the capital expended also showed a reduction of ¼ per cent. These two things made a difference of £1928. He was right in holding that these matters were all exceptional. The money they had was earmarked, and intended to meet further expenditure. Before 1910, the department would have to bear, whether or not they turned their water into revenue, the whole of their share of the charges of the first instalment of the Derwent Valley scheme, which was calculated to amount to more than £700,000. The share for the construction of the reservoirs was £507,000, and the cost of the Rivelin tunnel was £160,000 or £170,000; while further there was the expenditure for carrying the water from Hollow Meadows to the Hadfield reservoir. All this would mean that in 1910 there would be an additional charge on the finances of the Water Department, beyond what they had to-day, of the interest and sinking fund charges on more than £700,000, or £28,000 a year. The balance this year was £6000. How were they going to be able in 2¾ years to meet additional charges to this amount? It could be done only by large demands upon the accumulated funds they had for the purpose. Before the end of another month or two they would spend about £48,000 of this fund in the Rivelin Valley road scheme. In conclusion, he expressed the appreciation of the Committee, and he hoped of the Council, of the services rendered by Mr. Watts and Mr. Eaton, who concluded their service with the Corporation this month. Both gentlemen had been closely associated with the construction of the Little Don Valley works, and the work had been admirably done. The Lord Mayor (Alderman Styring), alluding to the completion of the Little Don Valley works, said that at the outset of the scheme there was a good deal of controversy as to whether or not the Corporation should do the work themselves; and it was satisfactory to know that the system adopted had been successful. He was quite sure that all who had seen the works would be satisfied that they were carried out in the most admirable manner. The minutes were confirmed.

## NOTES FROM SCOTLAND.

**From Our Own Correspondent.**

*Saturday.*

It was reported to the Dunfermline Town Council last Monday that the quantity of gas made during the past year was 118,629,600 cubic feet—an increase of 5,367,400 cubic feet, equal to 4·73 per cent. The quantity of gas accounted for amounted to 112,890,600 cubic feet—an increase of 6,420,900 cubic feet. For the current year a make of 117,175,000 cubic feet is estimated, with an income of £18,894, and a balance of £36. The Gas Committee recommended acceptance of tenders for coal, &c. Bailie Stewart, the Convener of the Committee, in moving approval of these recommendations and of the estimates, said the price of coal had increased by about 3s. per ton; but they thought that, by economizing in every possible manner, they would be able to continue to supply gas at the present prices. They were paying about £1153 more for coal; but, on the other hand, contracts for coke produced an enhanced revenue of £825, so that they had only to meet a difference of £328. They estimated for a less production of gas by a million-and-a-half cubic feet, as they wanted to keep on the safe side. A penny per 1000 cubic feet represented £488; and if it had not been for the increase in the price of coal, there might have been a reduction of 2d. per 1000 cubic feet in the price of gas. Treasurer Harley considered that they were in a very happy position, and were much indebted to their Engineer and Manager—Mr. A. Waddell. Provost Macbeth said he agreed with what had been said in praise of Mr. Waddell; but he would like, at the same time, to pay a compliment to Bailie Stewart, the Convener of the Gas Committee. Bailie Stewart said that he would like to see the Lighting Committee take full value of the gas they were using at present, which was not intended for flat-flame burners. If the Corporation persisted in using such burners, what did they expect the inhabitants to do? If the community would educate themselves up to the fact that gas of 21-candle power was a waste when consumed in incandescent burners, it would be better for the gas-works and consumers. The Convener's motion was adopted.

The Town Council of Troon have been in communication with the Under-Secretary for Scotland with reference to the repayment of the two loans which have been raised in connection with the Corporation Gas-Works. The Corporation have arranged that repayment be made in forty annual instalments. The Crown wish that the redemption should be made earlier. But the Gas Committee have instructed a reply to be sent to the effect that the arrangement has been come to with the agents for the lenders, who are satisfied, and that it cannot now be altered; and, further, that the Council are advised that the arrangement is legal, as in forty years the loans will be repaid, as required by the Statute.

The mutations which attend municipal government are well illustrated by the address of Treasurer Urquhart to the Dundee Town Council on Wednesday, in moving approval of the Gas and Electricity Departments' minutes. In 1901, when Mr. Ritchie was Treasurer, he succeeded in persuading the Council to adopt a scheme whereby the capital account could be reduced, so as to lighten the burden upon gas consumers, and enable gas to be sold at no very distant period at a cheaper rate. Their standing charges were then equal to 1s. 5d. per 1000 cubic feet, and they were in the act of extending their capital expenditure by about £60,000 for the reconstruction of the gas-works. On Mr. Ritchie's suggestion, it was agreed that that £60,000 should be wiped out in ten years; and I suppose this is being done. Now we have the present-day Treasurer inveighing against inflated profits—


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hidden surpluses, he calls them; and the feeling in the Council seems to be that gas should be cheapened to present consumers, and the heavy burden of capital passed on to futurity. In this case the Gas Department would remain at the mercy of every passing crisis, and there would be little hope of permanent relief to consumers. When it is stated that in 1901 the capital outlay in Dundee was equal to £7 7s. 1d. per ton of coal carbonized, as compared with £2 0s. 9d. in Glasgow, it should be apparent to everyone that, even at the expense of a higher price for a few years, a vigorous effort should be made to get the capital account as far down as possib'e.

It has been reported to the Newmilns Town Council that the quantity of gas manufactured during the year was 14,256,700 cubic feet—an increase over the previous year of 1,145,200 cubic feet. The coal carbonized amounted to 344 tons, and the yield of gas per ton was 10,607 cubic feet.

The annual meeting of the Carluke Gas Company, Limited, was held on Tuesday. The income was reported to have amounted to £2902, and the expenditure to £2051; leaving a profit on the year's working of £851. A dividend of 10 per cent. was declared, and a balance of £351 carried forward.

The Muirkirk Gas Company have paid a dividend of 7½ per cent., and retained the price of gas at 3s. 9d. per 1000 cubic feet. The Leslie Gas Company have paid a dividend at the rate of 7½ per cent. The Leven Gas Company have advanced the prices of gas to ordinary consumers by 2½d. per 1000 cubic feet; making them 3s. 6½d. and 4s. 4½d. per 1000 cubic feet. There is no increase in the price for street lighting. The Girvan Gaslight Company have paid a dividend at the rate of 7 per cent. At the annual meeting on Monday the shareholders resolved that the Company be converted into a limited liability one, and instructed the Secretary to have registration carried through without delay. The Dalbeattie Gaslight Company, Limited, have paid a dividend of 5 per cent., and have continued the price of gas at 5s. per 1000 cubic feet.

In the Arbroath Town Council on Monday, the Gas Committee reported that the quantity of gas manufactured during the past year amounted to 91,879,200 cubic feet—an increase over the previous year of 6,539,100 feet, and that the gas made per ton of coal was 9638 cubic feet—a decrease of 134 cubic feet. The quantity of gas sold was 83,234,657 cubic feet—an increase of 6,121,062 cubic feet. The total amount receivable for gas was £12,491—an increase of £976. The sum received for gas sold through ordinary meters, including gas used for power purposes, showed an increase of £244; and the amount received for gas sold through prepayment meters showed an increase of £732. The number of prepayment meters now in use is 2252—an increase of 297. The number of cookers, grillers, and rings now fixed for consumers is 2558—an increase of 835. The total cost of new mains laid during the year was £426. The Manager—Mr. A. C. Young—reported to the Gas Committee that he had now ascertained that the proposed advance of 2½d. in the price of gas would be sufficient to meet the increased expenditure and leave a fair margin, assuming the consumption of gas to be maintained at its present rate. The extra cost of material was equal to about 5d. per 1000 cubic feet; but owing to the actual result obtained in the production of gas per ton of coal, and the present high prices for residual products, an increase of 2½d. per 1000 cubic feet would suffice. The Committee recommended that gas be supplied to ordinary consumers at 3s. 1½d. per 1000 cubic feet, and through prepayment meters at 3s. 6½d.; the same rebate being allowed as formerly in the case of gas used for motive power—2½d. per 1000 cubic feet. Bailie Smith, the Convener of the Committee, moved approval of the Committee's minutes. Provost Alexander, in seconding, said he thought the Manager and the Convener deserved great credit. The minutes were adopted unanimously.

The Hamilton Town Council on Tuesday had before them the report of the Manager—Mr. J. Ballantyne—upon the sixteen tenders they had received for gas coal. Mr. Ballantyne submitted alternative lists for 13,000 tons. He also reported that if the railway siding had been formed into the works he would have recommended another selection at a saving of about £300 for that quantity of coal. The average price is 12s. 6d. per ton, as compared with 8s. 11d. last year. Bailie Hamilton, the Convener of the Gas Committee, moved approval of the recommendations. After some discussion they were agreed to.

The annual inspection of the Corporation Water-Works by the Glasgow Town Council took place last Thursday and Friday.

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**Ismailia Water Supply.**—Up to the present time, the town of Ismailia has been supplied with drinking water from a canal, which was greatly mixed with Nile water, sewage, and other impurities. The Suez Canal Company took the matter in hand, and they have installed works, which will be opened shortly. According to the Engineering Supplement to "The Times," these works were designed by M. Chabal, the Engineering Manager of the firm of Puech, of Paris, and the filters are constructed on the principle of the water-works in Paris. The canal water is taken through three strainers of the following dimensions (in cubic metres: No. 1, 26; No. 2, 42; No. 3, 70. It then flows into eight primary filters, filled with sand, each of 100 cubic metres capacity. The daily average will be 2000 cubic metres, or 440,000 gallons. The whole of the work, which is carried out in ferro-concrete, was completed under the supervision of M. Guillaumot.

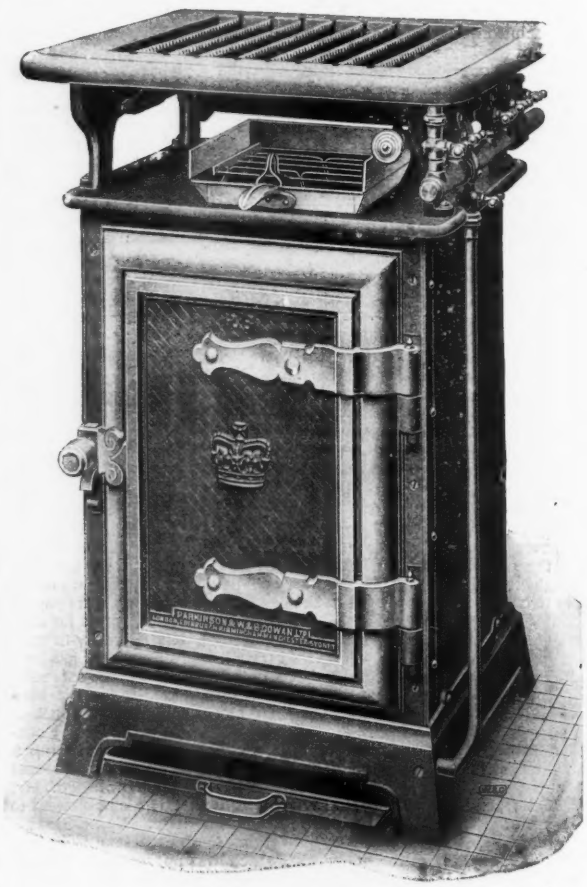
**Coventry Water Supply.**—A highly satisfactory result is shown in the annual report of the Water Committee of the Coventry Corporation. The receipts from water-rents for the past year amounted to £18,243, compared with £16,287 for the previous year. This figure is the highest in the history of the undertaking. The expenses were £10,116, or an increase of £2560; the addition being chiefly in the item of repairs of engines, boilers, &c., consequent on a breakdown at Whitley and a burst main in the centre of the city. The balance of revenue over working expenses is £8307, to which must be added bank interest £143, making a total of £8450. The capital charges amount to £5225, leaving a net profit of £3225, as against a profit last year of £4030. The unappropriated cash balance on March 31 was £4263. The Committee recommend that £4000 of the balance in hand be paid over to the borough fund in aid of the rates.

THE

"PARKINSON"

COOKER

"CROWN" PATTERN.



Supplied, if required, with

GAS AND AIR REGULATOR

Easy to manipulate and ensuring perfect combustion with all qualities of gas and at all pressures.

PARKINSON AND W. & B. COWAN, LTD.
(PARKINSON BRANCH),
COTTAGE LANE, CITY ROAD, LONDON.
BELL BARN ROAD, BIRMINGHAM.

## CURRENT SALES OF GAS PRODUCTS

**Sulphate of Ammonia.** LIVERPOOL, *June* 22.

There has been a quiet market throughout the week, and direct orders have been scarce, the buying being mainly for the purpose of covering July contracts. Consequently the trend of prices has again been in favour of buyers, especially on the east coast; the closing quotations being £11 13s. 9d. per ton f.o.b. Hull, £11 18s. 9d. per ton f.o.b. Liverpool, and £12 per ton f.o.b. Leith. In the early part of the week sales were reported to have been made for October-March delivery and for delivery over the spring months at £12 5s. per ton f.o.b. Scotch ports; but the buying has not been followed up, and at the close the price is not obtainable.

**Nitrate of Soda.**

This article is firm in all positions, and spot prices are 11s. per cwt. for ordinary quality, and 11s. 3d. for refined.

**Tar Products.** LONDON, *June* 22.

Tar products have been without interest during the past week, and there is practically no alteration in prices. The great firmness in pitch for forward delivery, and in creosote generally, continues unchanged. With regard to the market for pitch for prompt delivery, it is evident that there are one or two makers who are still anxious to sell some quantity for prompt; but naturally with the difficulties regarding shipment which exist at the present time, they find it hard to induce dealers to make them offers which are at all reasonable, though they appear willing to accept a fairly low figure. In London, it is reported that some small quantity was offered for prompt delivery at 26s. per ton; while in Manchester, parcels have been offered at 24s. without success. For forward delivery, the market remains in about the same position; and, although no important Continental business is reported, it is evident that consumers are more inclined to do business, and probably will sooner or later cover in a portion at any rate of their requirements for September-March. It is difficult to say what the actual value of pitch is for forward delivery; but manufacturers ask from 29s. 6d. to 30s. all round. Creosote is unchanged. London manufacturers ask from 2⅞d. to 3d. per gallon, and are not at all anxious to sell. With reference to the Midlands, the price of 2⅞d. mentioned last week was a clerical error. This should have been 3d.; and it is said that this figure has been obtained for small quantities, and 2⅞d. has been declined for a fair quantity of business. In the North, there are one or two sellers at from 2¾d. to 2⅞d. In the majority of cases, however, manufacturers ask 2⅞d.; and nowhere is there any anxiety to sell. Benzol, 90 per cent., is very quiet. It is reported that 9d., casks included, delivered to consumers' works, London, has been declined; while in the North, business is said to have been done at prices varying from 7d. to 8d. per gallon. Benzol, 50-90's, and toluol are both very weak, and there does not appear to be any demand for either article. Solvent naphtha is still weak, but rather firmer than the foregoing articles; but even in this article low figures have been taken for prompt delivery, except in London, where manufacturers are obtaining fairly good prices. Carbolic acid remains quiet, and there does not appear to have been a great amount of business doing. Anthracene is still entirely neglected.

The average values during the week were: Tar, 16s. to 20s. Pitch, London, 26s. nominal; east coast, 25s. 3d. to 25s. 9d.; west coast, 23s. 9d. to 24s. 6d. Benzol, 90 per cent., 8d. to 9d.; 50-90 per cent., 9½d. to 10½d. Toluol, 11d. to 1s. 1d. Crude naphtha, 4½d. to 4¾d.; solvent naphtha, 1s. 1d. to 1s. 3d.; heavy naphtha, 1s. 2d. to 1s. 4d. Creosote, London, 2⅞d. to 3d.; North, 2½d. to 2⅝d. Heavy oils, 3d. to 3¼d. Carbolic acid, 60 per cent., 1s. 7½d. to 1s. 8½d. Naphthalene, £6 10s. to £12 10s.; salts, 35s. to 45s. Anthracene, "A" quality, 1½d. to 1⅝d.

**Sulphate of Ammonia.**

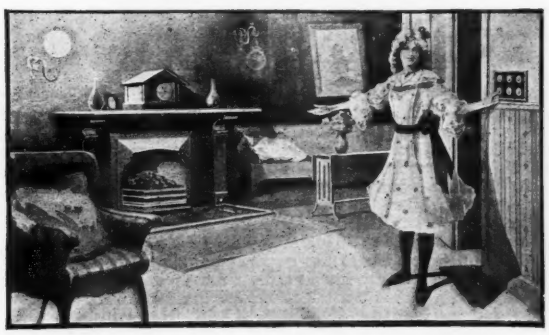
This article is steady, and prices remain unchanged. There does not appear to have been very much business doing, and dealers seem to be decidedly averse to paying the prices asked for forward delivery. In London, it is still possible to buy at £11 15s. on Beckton terms; but the principal Gas Companies are well sold, and quote from £12 2s. 6d. to £12 5s. In Leith, £12 would be possible for prompt, and £12 2s. 6d. for forward delivery; but makers ask £12 2s. 6d. and £12 5s. respectively, which figures they are unable to obtain at present. In Liverpool, some quantity of good make was offered at £11 18s. 9d. for prompt delivery without success; and the market varies from £11 16s. 3d. to £11 18s. 9d., according to the quality. In Hull, the market is quiet; and the value may be taken as about £11 15s.

**Reduction in Price at Wisbech.**—The Directors of the Wisbech Gas Company have decided to reduce the price of gas from 3s. 2d. to 3s. per 1000 cubic feet for lighting purposes, and from 3s. to 2s. 9d. for motive power.

**Conservation of Water in Wales.**—A joint conference of representatives of the several District and Rural Councils in Monmouthshire, which met at Newport last Wednesday, recommended that the County Council should promote a Bill next session with the object of conserving the sources of water supply recommended in the report by Mr. Baldwin Latham, and that such Bill should provide that the cost of it and of the acquisition of land should be a general county charge, to be recouped eventually out of the profits of the water undertaking when it reaches a profit-earning stage. At the close of the proceedings the conference was adjourned until the 10th prox. In the meantime, the Urban and Rural Councils will consider the resolutions passed to-day. Mr. Baldwin Latham recommended the construction of three large reservoirs in Breconshire, at a cost of £200,000, £250,000, and £280,000. The total cost of the works to supply 4 million gallons per day was estimated at £730,000. The Abergavenny Rural District Council have decided to object to the proposed scheme; the town being already well supplied.


# ELECTRIC LIGHT SUPERSEDED.

# PNEUMATIC DISTANCE GAS LIGHTER.



A FEW RECENT INSTALLATIONS.

| BUILDING. | Installed by |
|---|---|
| Madam Tussaud's, London | GASLIGHT AND COKE COMPANY LONDON. |
| Bethnal Green Fire Station (L.C.C.) | |
| The Albany, Piccadilly, W. | |
| St. Martin's Hall, Gospel Oak | |
| Christ Church, West Bromwich | LOCAL GAS COMPANIES. |
| Baptist Chapel, Redhill | |
| Christ Church, Wallington | |
| Holy Trinity Church, Wallington | |
| Baptist Chapel, Woodside | |
| Radcliffe Theatre, Radcliffe, Lancs. | |
| Theatre Royal, Chorley, | |
| St. Giles' Church, Willenhall | |
| Two Churches in Cardiff | |
| Town Hall, Banbury | |
| St. Luke's Church, Bath | |
| St. Paul's Church, Bath | |
| Conservative Club, Bath | |
| ,, ,, Ventnor | |
| Bathgate Church | |
| Royal York Hotel, Margate | PNEUMATIC GAS LIGHTING CO'S. FITTING DEPT. |
| St. Martin's Church, Bedford | |
| St. Paul's Church, Haggerston, N.E. | |
| Angel Hotel, Henley-on-Thames | |
| Red Lion Hotel, ,, | |
| Phyllis Court Club, ,, | |

New Council House, Smethwick. LOCAL GAS CO.

*N.B.*—This magnificent New Building was duplicated throughout at great expense for the Electric Light.

**ANOTHER VICTORY FOR GAS.**

*Our System is too well known throughout the Gas World to need explanation in these columns.*

**PNEUMATIC GAS LIGHTING CO., LTD.,**

**36, Farringdon Street, E.C.**

Telephone 2123 HOLBORN. Tele. Address: "OMNIBUSSES, LONDON."

## COAL TRADE REPORTS.

**Lancashire Coal Trade.**

There is no slackness in the demand for most classes of coal, and no reductions in price. The falling off in domestic fuel causes no inconvenience. What loss there is at present is infinitesimal. That the high rates prevailing are causing dissatisfaction among large users of coal is apparent from the action taken in endeavouring to bring down prices by venturing to new fields of supply. The agents of the Admiralty and the heads of the engineering departments of some of our English railway companies have been trying to secure coal from Scotland. Engine fuel is said to be too dear both in England and Wales. The fact is that other countries are absorbing large quantities. Besides the purchases for Continental use, coal is being sent from Hull and Grimsby to the United States. Perhaps as a retaliatory move on the part of railway companies, the rates for the carriage of coal, coke, and patent fuel are to be increased from the 1st of July next. Naturally, strong opposition is being offered on the part of coal owners. There are no changes to report in the average prices of coal and coke as last published.

**Northern Coal Trade.**

There is a stronger demand for coal—the local holidays being at hand, causing shippers to wish to get their exports well forward. And as the production has been full for the last few days, there is a heavy export proceeding. Best Northumbrian steam coals are from 14s. 3d. to 14s. 6d. per ton f.o.b., second-class steams are 14s., and steam smalls from 9s. 9d. to 10s. It is possible that during the next few days production and export of coals may be restricted by the cause above named. The gas coal trade is still active, with a very full demand for this season of the year. The shipments are heavy, both on home and Continental account; and this, and the good local demand, tends to keep up the prices. Durham gas coal varies from about 13s. to 14s. 6d. per ton f.o.b., according to the quality; but for one or two special classes the prices are higher, especially for early delivery. There are again some contracts in the market—such as that for Darlington. They are, however, usually allotted to collieries relatively near to the works; and it is tolerably certain that the general advance in the prices will be well upheld. Some of the French gas companies are seeking further supplies of gas coals in this district and in the south of Yorkshire, so that the market is full of inquiries. As to coke, prices are firm; and gas coke is steady. There are fair exports of gas coke; and the price is from 15s. 3d. to 15s. 6d. per ton f.o.b. in the Tyne.

**Scotch Coal Trade.**

Trade is booming, so far as quantity is concerned. Prices have ceased to rise. The export trade is exceptionally large, especially for small stuffs, for which there is a strong forward demand. Ell and splint are also in considerable request. The prices quoted are: Ell 12s. to 13s. 9d. per ton f.o.b. Glasgow, splint 12s. to 12s. 6d., and steam 11s. 9d. to 12s. The shipments for the week amounted to 307,601 tons—an increase of 27,217 tons upon the previous week, and of 37,017 tons upon the corresponding week of last year. For the year to date, the total shipments have been 6,391,111 tons—an increase of 319,402 tons upon the corresponding period of 1906.

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**Gas Explosion at Bootle.**—As the result of a gas explosion last week in a Bootle dwelling-house, three persons received injuries, the building was damaged, and a number of windows in the vicinity suffered. The cause of the explosion is said to have been the familiar one of "looking for an escape of gas with a light."

**St. Ives Water Supply.**—Owing to the recent revival of Cornish mining, the St. Ives Town Council are under the necessity of seeking for a fresh supply of water. The present supply is derived from mines which are about to be reworked; and the owners of the land and mineral rights have been in negotiation with the Corporation to induce them to surrender their present rights and construct works elsewhere. At a meeting yesterday week, the Special Works Committee reported that an offer had been made of £1000 for the surrender of the rights now possessed by the Council, and a lease of 99 years at a rental of £75 per annum of 6 acres of land at a place called Busson Moor, for the construction of a reservoir and for the collection and storage of the water over an area of about 500 acres. The Committee recommended the Council to require a cash payment of £3000, and to offer a rental of £50 per annum for the land at Busson Moor, together with the right to sink wells and pump the water. It was stated that the Surveyor had estimated the cost of a reservoir for the new supply at £15,000. It is, however, hoped that another source of supply will be secured at Zennor, in connection with which negotiations are in progress, and that the necessity of extensive storage works will be avoided. The recommendations of the Committee were adopted.

**Sales of Shares.**—At the Mart, Tokenhouse Yard, last Tuesday, Mr. Alfred Richards offered for sale several parcels of gas and water stocks and shares, including some new issues. The first lots consisted of 5 per cent. ordinary stock of the South Essex Water-Works Company, ranking for a maximum dividend of 5 per cent., but carrying 4¼ per cent. as from the 1st prox. It fetched from £105 to £105 10s. per £100 of stock. A new issue of ordinary "C" stock of the Wandsworth and Putney Gas Company was next offered, ranking for a standard dividend of 3½ per cent., subject to the sliding-scale, and carrying £5 12s. per cent. as from the 1st prox., was sold for £120 per £100 of stock. Another new issue, consisting of £5000 of consolidated ordinary 5 per cent. stock of the Chigwell, Loughton, and Woodford Gas Company (the last dividend on stock of this class having been at the rate of 5¼ per cent. per annum), fetched from £104 to £105 per £100. A number of shares in the Plymouth Gas Company were offered for sale by auction in the town on Thursday. For ordinary stock in the Company, which is paying 6⅛ per cent., the highest price bid was £124 per £100, at which the stock was withdrawn. Several lots of additional shares (£10 each) were sold at £20 2s. 6d. per share; and some new shares were sold at £19 11s. per share.


# "CANNON"

# Our Chairman Smiled

When he read the article:—

## "The Present and Future of Gas Cookers and the Trade,"

(Commencing on p. 658 of the GAS WORLD of 25th May, 1907).

## As the PIONEERS of Progress and Economy

we have had our reward, as proved by the enormous growth of our works.

## EXAMINE OUR COOKERS!!
## Observe the Advantages!!

SEE OUR CATALOGUES OF
**COOKERS,**
**FIRES, and**
**METERS.**

SLOT INSTALLATIONS COMPLETE.

**Value for Money.**

## CANNON IRON FOUNDRIES, LTD.,

**DEEPFIELDS, Nr. Bilston, STAFFS.**

*London Office and Show-Rooms:*

**Bath House, 57-60, Holborn Viaduct, E.C.**

**Australasian Agents:**
JAMES HURLL & CO., Ltd., 20, Loftus Street, SYDNEY,
*and Box No. 4 (G.P.O.) Dunedin.*

The Directors of the Richmond Gas Stove and Meter Company, Limited, have declared an interim dividend for the six months ending June 30 at the rate of 6 per cent. per annum on the £5 cumulative preference shares, and at the rate of 10 per cent., free of income-tax, on the £1 ordinary shares.

The contract for the structural steel buildings for the gas-producer and boiler houses, together with the coal conveyors, elevators, overhead storage bunkers, and accessories, for the new branch of the Clarence Steel-Works, now being erected on the Manchester Ship Canal, has been placed with the Gilbert Little Company, Limited, of Bradford.

On the recommendation of the Gas Manager the St. Ives, Cornwall, Town Council have decided to supply gas cooking stoves on the hire system. It was also resolved that rent for the use of meters be reduced to an amount equal to 12½ per cent. on the net cost of the meters.

The discovery of a new fuel "Ceria," from which it is claimed 15 per cent. more heat is obtained than from any other which has been tested against it, is expected to give an impetus to the sale of gas-fires. Extensive experiments have been carried out by the inventor and patentee, Mr. W. Edgar, of Hammersmith, and are stated to fully justify the claim made for the fuel.

## LEAFLETS FOR DISTRIBUTION.

"ILLUMINATING TRUTHS FOR HOUSEHOLDERS."

No. 1.—"The Sanitary Aspects of Gas and Electric Lighting."
No. 2.—"The Cleanliness of Illuminants: The Eyesight."
No. 3.—"Fire Risks."
No. 4.—"The Relative Cost of Gas and Electricity, and Matters affecting it."
No. 5.—"On Reliability, with Instances of Misplaced Confidence."
No. 6.—"On Shop Lighting, with Special Reference to the Flame Arc Lamp."

*This series of Leaflets will be useful, not only or distribution among Householders generally, but for circulation among Shareholders to fortify them with arguments in defence of the commodity in which they have invested capital. Copies of each Leaflet should also be kept in every Gas Undertaking's Show-Rooms.*

*Prices for Quantities on Application to* WALTER KING, 11, BOLT COURT, FLEET STREET, E.C.

## WANTED, FOR SALE, CONTRACT, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

**Situations Vacant.**

ENGINEER. Scottish National Exhibition, Edinburgh. Applications by July 8.
GAS ENGINEER TO REPRESENT GAS PLANT COMPANY. No. 4792.
TEACHER (GAS MANUFACTURE). Birmingham Municipal Technical School.
DRAUGHTSMAN (Temporary). C. & W. Walker. Donnington.

**Situations Wanted.**

CHEMIST. Karstaedt, Old Charlton.
MANAGER OR ASSISTANT. No. 4786.
SULPHATE OF AMMONIA LEAD WORK. No. 4791.
WORKING MANAGER, FOREMAN, &c. No. 4790.

**Gas Manufacture Correspondence Classes.**

CORRESPONDENCE COLLEGE COMPANY, CAMBRIDGE.

**Licences for Manufacturing Patent Purifier Grids.** No. 4787.

**Plant (Second-Hand), &c., for Sale.**

METERS (8.0-LIGHT). H.M. Dockyard, Portsmouth.
STATION METER. Whittington Gas Company.
STATION METER, ENGINE AND EXHAUSTER, PURIFIERS, SCRUBBERS, WASHERS, ENGINES AND BOILERS, AND OTHER GAS WORKS PLANT. Hastings Gas Company.

**Plant, &c. (Second-Hand), Wanted.**

SCRUBBERS AND WASHERS. "Gas Works," c/o Vickers.

**Gas-Works for Disposal.**

KENT COUNTY GASLIGHT AND COKE COMPANY. (In Liquidation.)

**Stocks and Shares.**

BARNET GAS AND WATER COMPANY. July 2.
ILFORD GAS COMPANY. July 2.
READING GAS COMPANY. July 2.
SEVENOAKS GAS COMPANY. July 2.
ST. MARGARETS GAS COMPANY. July 2.
TOTTENHAM GAS COMPANY. July 2.
WEST HAM GAS COMPANY. July 2.
WORTHING GAS COMPANY. July 2.

**TENDERS FOR**

**Boiler Plant, &c.**

COVENTRY CORPORATION. Tenders by July 8.

**Coal and Cannel.**

BARNOLDSWICK GAS DEPARTMENT. Tenders by July 6.
EXMOUTH GAS COMPANY. Tenders by June 29.
ILKESTON GAS DEPARTMENT. Tenders by July 3.
LINCOLN GAS DEPARTMENT. Tenders by July 15.
LONGTON CORPORATION. Tenders by July 2.
ROTHERHAM GAS DEPARTMENT. Tenders by July 10.
SAFFRON WALDEN UNION. Tenders by July 1.
SOUTH OXFORDSHIRE WATER AND GAS COMPANY. Tenders by July 3.
TEIGNMOUTH GAS DEPARTMENT. Tenders by July 1.
WINSFORD DISTRICT COUNCIL. Tenders by July 9.

**Coke.**

SAFFRON WALDEN UNION. Tenders by July 1.

**General Stores, Lead, Oils, Paints, &c.**

SALFORD GAS DEPARTMENT. Tenders by July 4.

**Iron and Steel, &c.**

SALFORD GAS DEPARTMENT. Tenders by July 4.

**Meters and Fittings.**

SALFORD GAS DEPARTMENT. Tenders by July 4.

**Pipes and Castings, &c.**

SALFORD GAS DEPARTMENT. Tenders by July 4.

**Refuse Destructor, Boiler Plant, &c.**

COVENTRY CORPORATION. Tenders by July 8.

**Tar and Liquor.**

ALTRINCHAM GAS COMPANY. Tenders by July 9.
HANWELL ASYLUM. Tenders by June 29.
LONGTON CORPORATION. Tenders by July 2.
ROTHERHAM GAS DEPARTMENT. Tenders by July 10.
ROTHWELL GAS DEPARTMENT. Tenders by July 9.

## GAS COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 991.

| Issue. | Share. | When ex-Dividend. | Dividend or Dividend & Bonus. | NAME. | Closing Prices. | Rise or Fall in Wk. | Yield upon Investment. |
|---|---|---|---|---|---|---|---|
| £ | | | p.c. | | | | £ s. d. |
| 500,000 | 10 | Apl. 11 | 10½ | Alliance & Dublin 10 p.c. | 20—21 | .. | 5 0 0 |
| 268,324 | 10 | ,, | 7½ | Do. 7 p.c. | 13½—14½ | .. | 5 3 5 |
| 200,000 | 5 | May 15 | 7 | Bombay, Ltd. | 6½—7 | .. | 5 0 0 |
| 40,000 | 5 | ,, | 7 | Do. New, £4 paid | 4½—5½ | .. | 5 6 8 |
| 50,000 | 10 | Feb. 28 | 14 | Bourne-mouth Gas and Water: 10 p.c. | 27½—28½ | .. | 4 18 3 |
| 51,810 | 10 | ,, | 7 | Bourne-mouth Gas and Water: B 7 p.c. | 16½—17 | .. | 4 2 4 |
| 53,200 | 10 | ,, | 6 | Bourne-mouth Gas and Water: Pref. 6 p.c. | 15—16 | .. | 3 15 0 |
| 380,000 | Stk. | ,, | 12½ | Brentford Consolidated | 245—250 | .. | 5 0 0 |
| 300,000 | ,, | ,, | 9½ | Do. New | 188—193 | .. | 4 18 5 |
| 50,000 | ,, | ,, | 5 | Do. 5 p.c. Pref. | 117—122 | .. | 4 2 0 |
| 206,250 | ,, | June 13 | 4 | Do. 4 p.c. Deb. | 100—103* | .. | 3 17 8 |
| 220,000 | Stk. | Mch. 14 | 11½ | Brighton & Hove Orig. | 220—225 | .. | 5 0 0 |
| 246,320 | ,, | ,, | 8½ | Do. A. Ord. Stk. | 160—165 | .. | 5 0 0 |
| 460,000 | 20 | Apl. 11 | 10 | British | 41—43 | .. | 4 13 0 |
| 104,000 | Stk. | Feb. 28 | 6 | Bromley, Ord. 5 p.c. | 119—122 | .. | 4 18 4 |
| 165,700 | ,, | ,, | 4½ | Do. do. 3½ p.c. | 90—93 | .. | 4 16 9 |
| 500,000 | 10 | May 15 | 7 | Buenos Ayres (New) Ltd. | 11—11½ | .. | 6 1 9 |
| 250,000 | Stk. | Dec. 13 | 4 | Do. 4 p.c. Deb. | 95—97 | .. | 4 2 6 |
| 150,000 | 20 | Mch. 14 | 8½ | Cagliari, Ltd. | 25—27 | .. | 5 17 10 |
| 100,000 | 10 | June 13 | 10 | Cape Town & Dis., Ltd. | 11—13* | .. | 7 13 10 |
| 100,000 | 10 | Apl. 26 | 4½ | Do. 4½ p.c Pref. | 8½—9½ | .. | 4 14 9 |
| 50,000 | 50 | May 2 | 6 | Do. 6 p.c. 1st Mort. | 50—52 | .. | 5 15 5 |
| 50,000 | Stk. | Dec. 28 | 4½ | Do. 4½ p.c. Deb. Stk. | 56—98 | .. | 4 11 10 |
| 157,150 | Stk. | Feb. 28 | 5 | Chester 5 p.c. Ord. | 109—111 | .. | 4 10 1 |
| 1,143,280 | Stk. | ,, | 5⅛ | Commercial 4 p.c Stk. | 105—108 | .. | 4 16 4 |
| 360,000 | ,, | ,, | 5 | Do. 3½ p.c. do. | 102—105 | .. | 4 15 3 |
| 475,000 | ,, | June 13 | 3 | Do. 3 p.c. Deb. Stk. | 81—83* | —1 | 3 12 3 |
| 800,000 | Stk. | ,, | 6¼ | Continental Union, Ltd. | 112—117* | .. | 5 11 1 |
| 200,000 | ,, | ,, | 7 | Do. 7 p.c. Pref. | 136—141* | .. | 4 19 3 |
| 460,170 | Stk. | — | 5⅛ | Derby Con. Stk. | 122—124 | .. | 4 8 9 |
| 55,000 | ,, | Jan. | 4 | Do. Deb. Stk. | 103—105 | .. | 3 16 2 |
| 486,090 | 10 | Jan. 31 | 12† | European, Ltd. | 23—24 | —½ | 5 0 0 |
| 354,060 | 10 | ,, | 12† | Do. £7 10s. paid | 17½—18½ | —½ | 4 17 4 |
| 15,203,110 | Stk. | Feb. 14 | 4⅛ | Gaslight and Coke: 4 p.c. Ord. | 92—93 | +½ | 4 14 7 |
| 2,600,000 | ,, | ,, | 3½ | Gaslight and Coke: 3½ p.c. max. | 87—89 | .. | 3 18 8 |
| 3,799,735 | ,, | ,, | 4 | Gaslight and Coke: 4 p.c. Con. Pref. | 102—105 | .. | 3 16 2 |
| 4,193,975 | ,, | June 13 | 3 | Gaslight and Coke: 3 p.c. Con. Deb. | 82—84* | .. | 3 11 5 |
| 258,740 | Stk. | Mch. 14 | 5 | Hastings & St. L. 3½ p.c. | 95—100 | .. | 5 0 0 |
| 82,500 | ,, | ,, | 6½ | Do. do. 5 p.c. | 116—119 | .. | 5 9 3 |
| 70,000 | 10 | Apl. 26 | 11 | Hongkong & China, Ltd. | 17—20 | .. | 5 10 0 |
| 4,940,000 | Stk. | May 15 | 8 | Imperial Continental | 169—172 | .. | 4 13 0 |
| 473,600 | Stk. | Feb. 14 | 3½ | Do. 3½ p.c. Deb. Red. | 93—95 | .. | 3 13 8 |
| 184,602 | Stk. | Mch. 14 | 6 | Lea Bridge Ord. 5 p.c. | 110—120 | .. | 5 0 0 |
| 306,083 | ,, | Dec. 28 | 4 | L'rpool Unit'd Deb. Stk. | 110—112 | .. | 3 11 5 |
| 561,000 | Stk. | Feb. 28 | 10 | Liverpool United A | 222—224 | —1 | 4 9 3 |
| 718,100 | | ,, | 7 | Do. B | 163½—164½ | .. | 4 5 1 |
| 144,140 | Stk. | Feb. 14 | 7⅛ | Maidstone 5 p.c. | 142—147 | .. | 5 3 8 |
| 75,000 | 5 | Nov. 29 | 5 | Malta & Medn., Ltd. | 4¼—4⅝ | .. | 5 5 3 |
| 560,000 | 100 | Apl. 2 | 5 | Met. of 5 p.c. Deb. | 100—102 | .. | 4 18 0 |
| 250,000 | 100 | ,, | 4½ | Melbourne 4½ p.c. Deb. | 100—102 | .. | 4 8 3 |
| 541,920 | 20 | May 30 | 3¼ | Monte Video, Ltd. | 10½—11½ | .. | 6 1 9 |
| 1,775,892 | Stk. | Feb. 28 | 4⅝ | Newc'tle & G'tesh'd Con. | 105—107 | .. | 4 6 5 |
| 406,025 | Stk. | Dec. 28 | 3½ | Do. 3½ p.c. Deb. | 96—97 | .. | 3 12 2 |
| 15,000 | 10 | Feb. 28 | 10 | North Middlesex 10 p.c. | 19½—20½ | .. | 4 17 7 |
| 55,940 | 10 | ,, | 7 | Do. 7 p.c. | 13—14 | .. | 5 0 0 |
| 300,000 | Stk. | Apl. 26 | 8 | Oriental, Ltd. | 143—148 | .. | 5 8 1 |
| 60,000 | 5 | Mch. 27 | 7 | Ottoman, Ltd. | 6—6½ | .. | 5 7 8 |
| 398,490 | 5 | May 15 | 7 | Primitiva Ord. | 6¾—7¼ | .. | 4 16 7 |
| 796,980 | 5 | Jan. 31 | 5 | Do. 5 p.c. Pref. | 4⅝—5⅛ | —⅛ | 4 17 7 |
| 488,900 | 100 | June 1 | 4 | Do. 4 p.c. Deb. | 93—95 | .. | 4 4 3 |
| 1,000,000 | 10 | Apl. 26 | 8 | River Plate Ord. | 12¾—13¼ | .. | 6 0 9 |
| 312,650 | Stk. | Dec. 28 | 4 | Do. 4 p.c. Deb. | 95—97 | .. | 4 2 6 |
| 250,000 | 10 | Mch. 27 | 8 | San Paulo, Ltd. | 12½—13 | .. | 6 3 1 |
| 125,000 | 50 | Jan. 2 | 5 | Do. 5 p.c. Deb. | 49—51 | .. | 4 18 0 |
| 135,000 | Stk. | Mch. 14 | 10 | Sheffield A | 245—247 | .. | 4 1 0 |
| 209,984 | ,, | ,, | 10 | Do. B | 245—247 | .. | 4 1 0 |
| 523,500 | ,, | ,, | 10 | Do. C | 245—247 | .. | 4 1 0 |
| 70,000 | 10 | June 13 | 10 | South African | 15—16* | .. | 6 5 0 |
| 6,350,000 | Stk. | Feb. 14 | 5⅛ | South Met., 4 p.c. Ord. | 118—121 | —2½ | 4 10 11 |
| 1,895,445 | ,, | Jan. 16 | 3 | Do. 3 p.c. Deb. | 83—85 | .. | 3 10 7 |
| 201,720 | Stk | Mch. 14 | 8 | South Shields Con. Stk. | 157—159 | .. | 5 0 8 |
| 605,000 | Stk. | Feb. 28 | 5½ | S'th Suburb'n Ord. 5 p.c. | 117—121 | —1½ | 4 10 11 |
| 60,000 | ,, | ,, | 5 | Do. 5 p.c. Pref. | 120—123 | .. | 4 10 11 |
| 117,058 | ,, | Jan. 16 | 5 | Do. 5 p.c. Deb. Stk. | 125—130 | .. | 3 16 11 |
| 502,310 | Stk. | May 15 | 5 | Southampton Ord. | 105—110 | .. | 4 10 11 |
| 120,000 | Stk. | Feb. 28 | 6½ | Tottenham and Edmonton: A 5 p.c. | 123—126 | .. | 5 3 2 |
| 398,940 | ,, | ,, | 5 | Tottenham and Edmonton: B 3½ p.c. | 101—103 | .. | 4 17 1 |
| 137,500 | ,, | Dec. 28 | 4 | Tottenham and Edmonton: 4 p.c. Deb. | 101—103 | .. | 3 17 8 |
| 182,380 | 10 | June 13 | 8 | Tuscan, Ltd. | 10¼—10¾* | .. | 7 8 10 |
| 149,900 | 10 | Jan. 2 | 5 | Do. 5 p.c. Deb. Red. | 102—104 | .. | 4 16 2 |
| 193,742 | Stk. | Feb. 28 | 5 | Tynemouth 5 p.c. max. | 106—108 | .. | 4 12 7 |
| 30,000 | Stk. | Feb. 14 | 8 | Wandsworth A 5 p.c. | — | .. | — |
| 255,636 | ,, | ,, | 6½ | Wandsworth B 3½ p.c. and C 3½ p.c. | 133—138 | .. | 4 14 2 |
| 75,000 | ,, | ,, | 5⅝ | Wandsworth C 3½ p.c. | — | .. | — |
| 79,416 | ,, | Dec. 28 | 3 | Putney 3 p.c. Deb. Stk. | 79—82 | .. | 3 13 2 |
| 845,872 | ,, | Feb. 28 | 5⅛ | West Ham 5 p.c. Ord. | 102—105 | .. | 4 17 7 |
| 185,000 | ,, | ,, | 5 | Do. 5 p.c. Pref. | 120—123 | .. | 4 1 4 |
| 228,300 | ,, | Dec. 28 | 4 | Do. 4 p.c. Deb. Stk. | 102—105 | .. | 3 16 2 |

Prices marked * are "Ex div." † Next dividend will be at this rate.

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# THE JOURNAL OF GAS LIGHTING
## WATER SUPPLY & SANITARY IMPROVEMENT

[REGISTERED AS A NEWSPAPER.

VOL. XCVIII. No. 2302.] LONDON, JUNE 25, 1907. [59TH YEAR. PRICE 6d.



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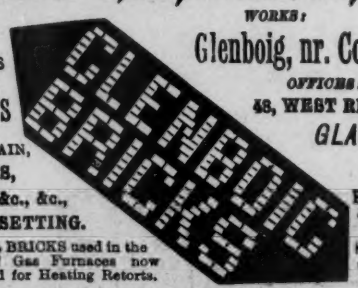


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—48—

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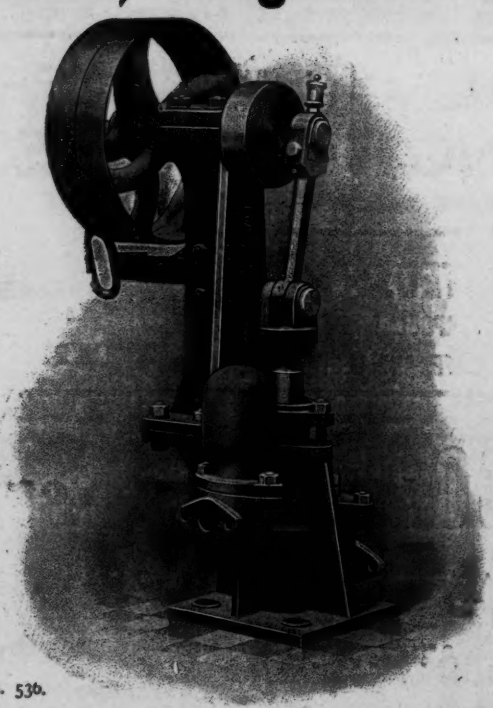

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# THE JOURNAL OF GAS LIGHTING
## WATER SUPPLY & SANITARY IMPROVEMENT

VOL. XCVIII. No. 2302.] LONDON, JUNE 25, 1907. [59TH YEAR. PRICE 6d.



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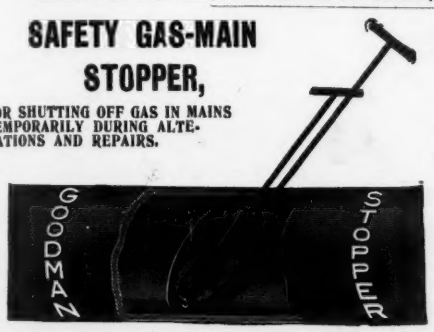


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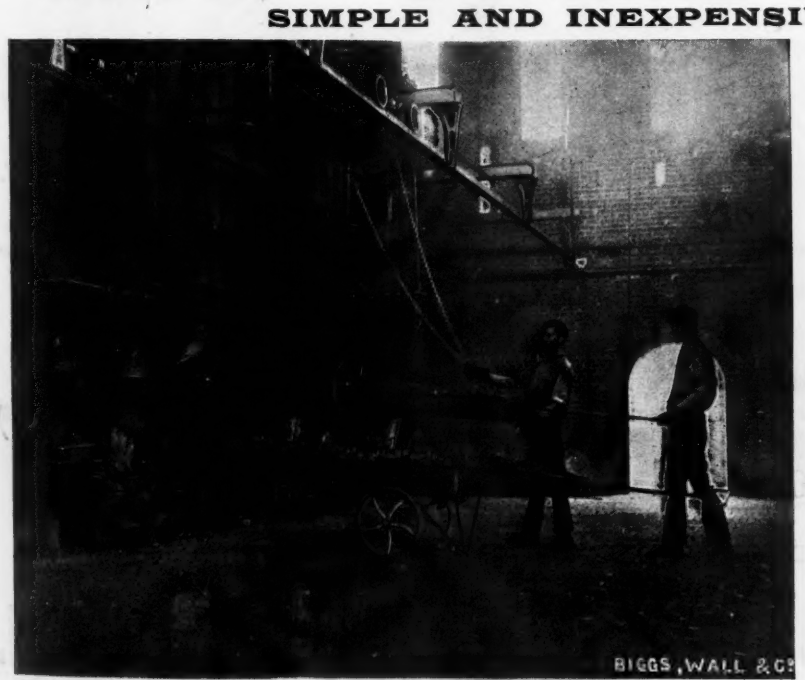


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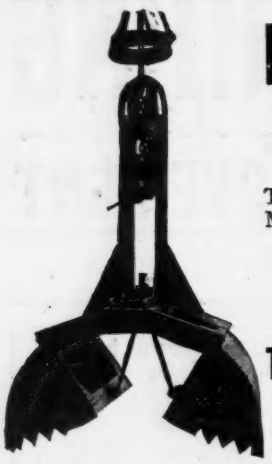

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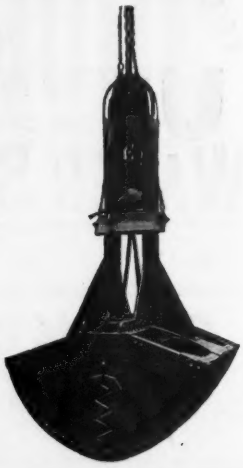

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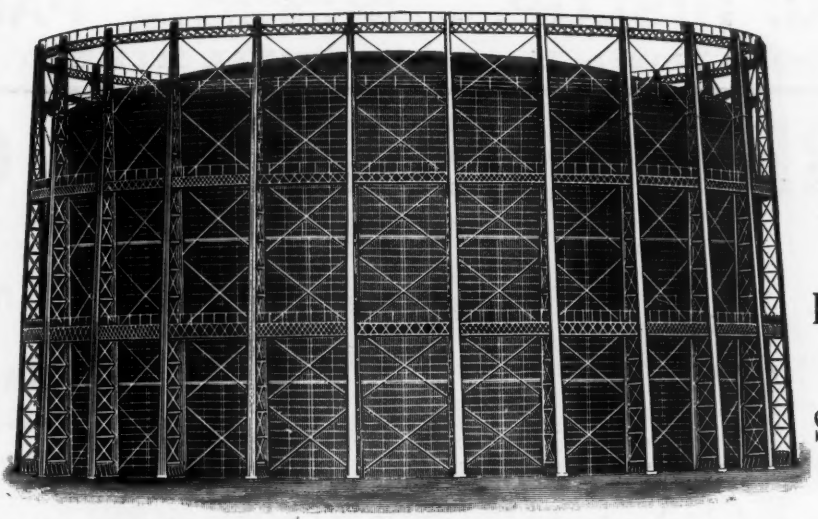

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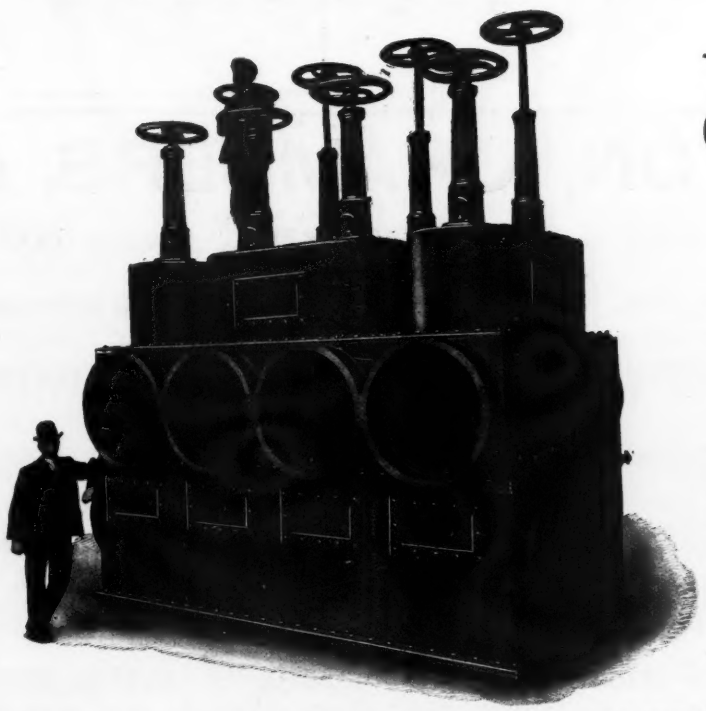

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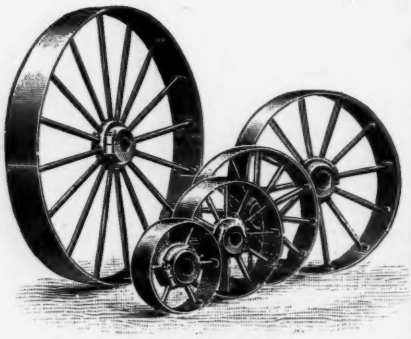

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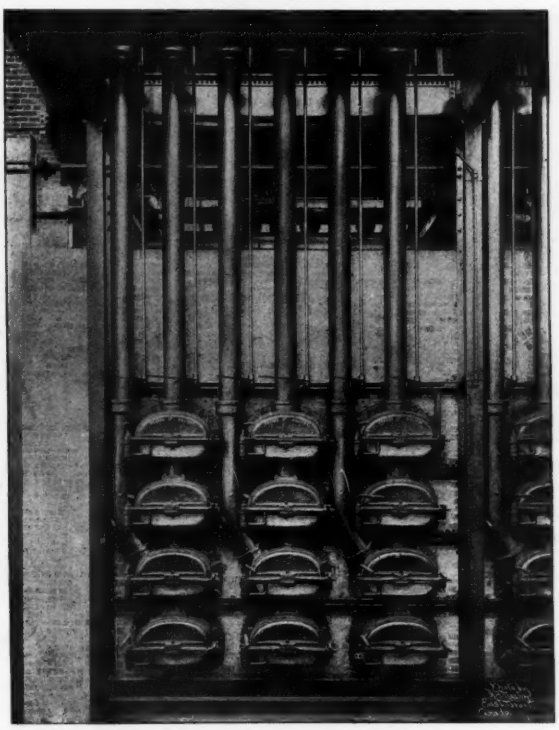

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**Illustration of a bed of 12 "D" Retorts with Ironwork complete.**

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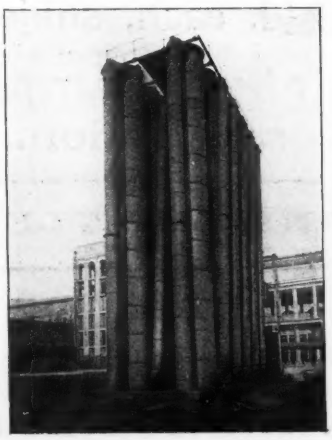

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# WELSBACH LIGHT

**(PATENTED)**

Fig. 35. 100 c.p.

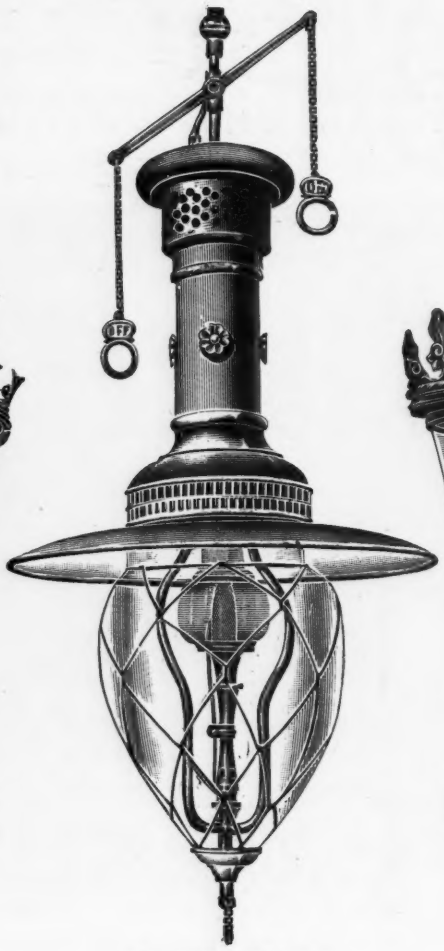

Fig. 607. 600 c.p.
Self-Intensifying.

Fig. 35a. 300 c.p.
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**4½d. each, subject.**

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**EACH LAMP AND MANTLE GUARANTEED.**

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# Extracts from a Photometrist's Note Book.

A Paper read before the North of England Gas Managers' Association, April 28, 1906, by Mr. James Foreman.


# WELSBACH LIGHT.

| Type. | Claimed by Welsbach Co. Candle Power. | Claimed by Welsbach Co. Consumption. Feet. | Actual. Candle Power. | Actual. Consumption. Feet. | Cost of Gas only for 1000 C. P. for One Hour. Gas at 2s. 6d. per 1000 Feet. Pence. |
|---|---|---|---|---|---|
| Welsbach "C" Burner | 60 | 3¾ | 77 | 3½ | 1·85 |
| Welsbach Kern No. 4 Burner | 100 | 4 | 126 | 5·17 | 1·599 |
| Welsbach Kern Inverted Burner | 65 | 3 | 56·4 | 2·76 | 1·41 |
| Welsbach Kern Self-Intensifying Lamp | 600 | 20 | 615 | 19 | 1·26 |

The above figures for every type of commercial light constitute the Most Remarkable Series of **INDEPENDENT TESTS** ever made. Comment is needless.

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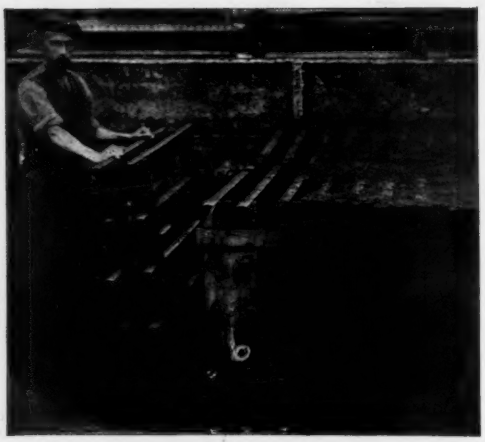
# PATENT "STANDARD" GRIDS



Supplied with **DOUBLE** or **SINGLE** row of "ridged" bars and for use **WITH** or **WITHOUT** bottom tier of "Ordinary" Grids.

Extract from letter referring to Grids shown in Illustration:—

"The Grids were fixed for one reason only and that was to endeavour to **reduce the Pressure** from which we were troubled. For that reason I had the Purifier fitted with **Oxide similar to that from which we experienced most trouble,** that I might clearly satisfy myself as to the benefit, if any, to be derived from the use of your Patent Grids; so that the comparison I gave you was the **actual result of the Purifier fitted with your Patent Grids over the Ordinary Grids we had previously used.**"

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DESIGN No. 2 PATTERN.

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WE have Devised and Patented a Slot Attachment which for simplicity and reliability equals any attachment yet introduced.

Our Meter is now complete in every respect, and equal to all demands of modern methods of Gas Distribution.

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THE BEST "SLOTS" MADE

AND

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Nos. 189 and 190 Designs.

MOST COMPACT AND CONVENIENT.

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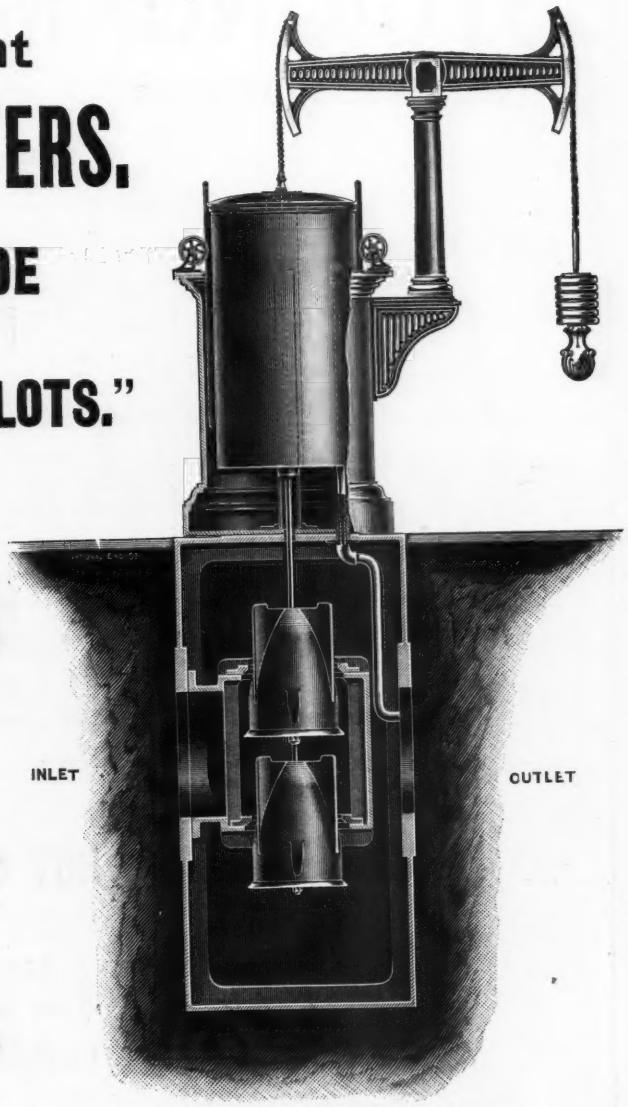
Particulars upon Application.




GOVERNOR, No. 190 Type.

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(OF ALL CAPACITIES UP TO 300,000 CUBIC FEET PER HOUR)

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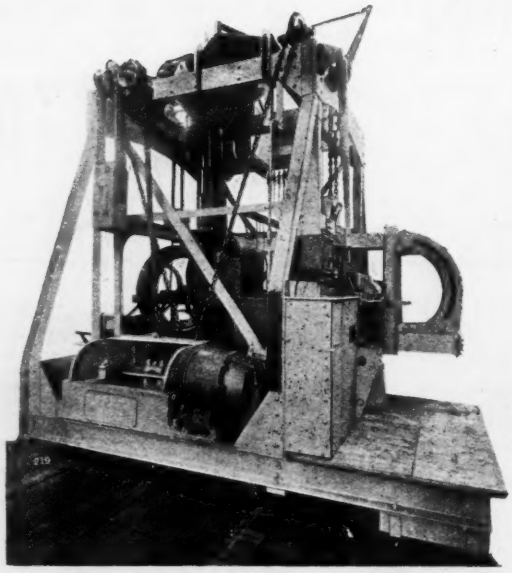

The "COMPLETE STOKER," suitable for Retort-Houses containing not more than 10 beds.

**51**

Installations of "DE BROUWER"

**PATENT PROJECTORS**

AND

**32**

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Also Sole Manufacturers of the

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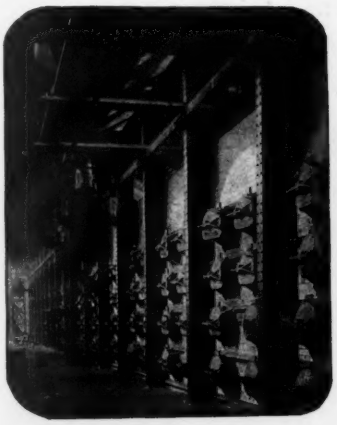

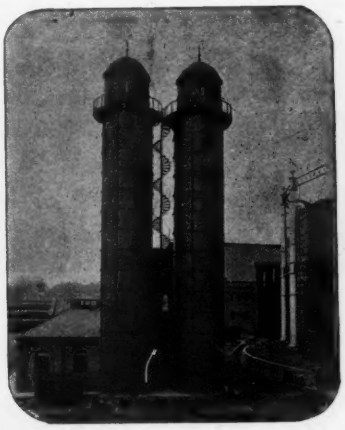

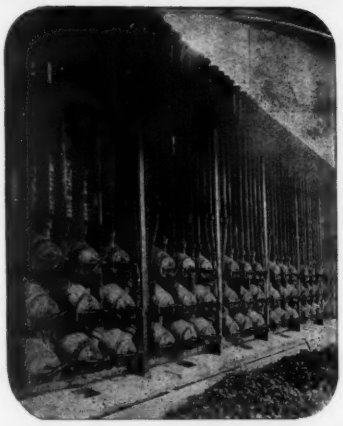

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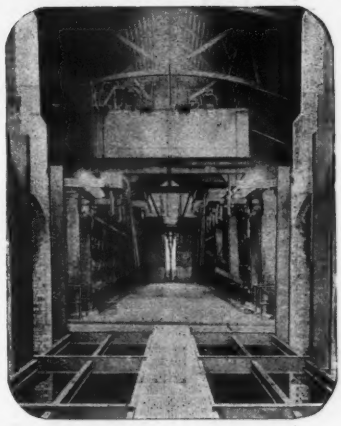

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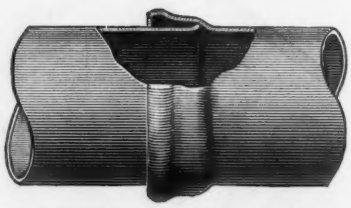
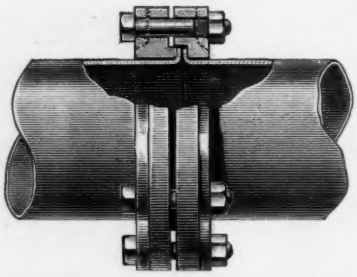
**with**
**STEWARTS' PATENT INSERTED JOINT**
**for LEAD and YARN,**
for Gas, Water, Air, Sewage, and Hydro-Electric Power Mains.



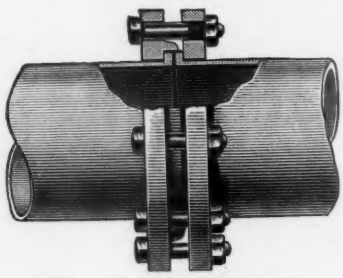
Stewarts' Patent Inserted Joint.

## LIGHT LAPWELDED WROUGHT-IRON and STEEL PIPES

**with "Stewarts' Patent" or "Albion" Loose Flange Joints.**



Stewarts' Patent Loose Flange Joint.



Albion Loose Flange Joint.

## TUBES & FITTINGS for PERKINS' or other HEATING SYSTEMS.

## MAIN STEAM PIPE INSTALLATIONS.

## WROUGHT-IRON SCREWED AND COUPLED TUBES AND FITTINGS

**for Gas, Water, Steam, Air, &c.**

## CAST-IRON PIPES & CONNECTIONS.

## SIEMENS-MARTIN STEEL PLATES for BOILERS, BRIDGES, TANKS, &c.

# J. TAYLOR & CO.,

## Central Plumbing Works,

## BOLTON.

Saturators also in hand for Messrs. Kempson & Co., Pye Bridge Chemical Works, near Alfreton, and the Dumfries Corporation Gas Department.

Photo. recently taken in our Works, showing various builds of SATURATORS, and ACID TANKS, &c.

# 226

## SATURATORS RECENTLY SUPPLIED.

### REPAIRS A SPECIALITY.

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**Gas Engineers, Ironfounders, and Contractors,**

**LONDON & EXETER.**

**Makers of every description of**

## Gas Plant and Iron and Steel Constructional Work.

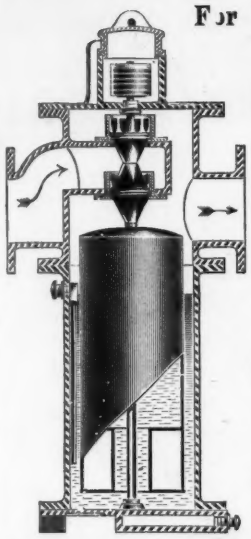
| | |
|---|---|
| **INCLINED RETORTS** | **SOLE AGENTS** IN THE UNITED KINGDOM FOR THE **DIDIER** (STETTIN) **REGENERATIVE SYSTEM.** |
| **PURIFIERS** | WITH WATER LUTE OR LUTELESS COVERS. |
| **CENTRE VALVE** | PICKERING'S PATENT, GREAT SAVING EFFECTED, NO CONNECTIONS REQUIRED. |
| **GASHOLDERS** | WITH OR WITHOUT STEEL TANKS. |
| **MOUTHPIECES** | WITH TYSOE'S PATENT FASTENING. |
| **STATION GOVERNORS** | WITH PATENT EQUILIBRIUM VALVE, PRESSURE ABSOLUTELY CONSTANT. |
| **STATION METERS** | IN CYLINDRICAL CASES TO 30,000 FEET PER HOUR, IN SQUARE CASES UP TO 200,000 FEET PER HOUR. |
| **WET AND DRY METERS** | OF THE HIGHEST EXCELLENCE IN MATERIALS AND WORKMANSHIP. |
| **SLOT METERS** | FROM 2-LT. TO 100-LT. FOR ANY COIN, POSITIVE IN ACTION, ABSOLUTELY ACCURATE, TENS OF THOUSANDS IN USE. |
| **"STANDARD" COOKERS** | HIGHEST GRADE, ALL PARTS INTERCHANGEABLE, BURNERS DETACHABLE, CLEAN, ECONOMICAL, SAFE, AND DURABLE. |
| **SLOT COOKERS** | IN CAST-IRON. FITTED WITH LATEST IMPROVEMENTS. |
| **SLOT INSTALLATIONS** | HOUSES FITTED THROUGHOUT WITH SERVICES, METERS, STOVES, AND GAS-FITTINGS OF SPECIAL STRENGTH. |

## Gas Fittings, &c.

NEW PATENT UNDERGROUND DISTRICT

# GAS GOVERNOR

For Constant Pressure.



BALANCED VALVES.

Loading by Weights or Separate Air Vessel.

INLET PRESSURE

Has no Effect on Water Seal.

OCCUPIES SMALL SPACE.

**BRUCE PEEBLES & CO., LTD.,**

Tay Works, Bonnington,

Telegrams: "TANGENT EDINBURGH."
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**EDINBURGH.**

"ACME" Gas Cookers

Used in the Royal Kitchens

All parts interchangeable, thus reducing cost of maintenance.

Porcelain Enamelled Oven Lining.

Screw Fastenings incorrodible.

Burners removable—also their Carriers.

Grilling Burner of exceptional efficiency, with reduced gas consumption.

Ebony Door Knobs.

MECHANICAL COAL HANDLING PLANTS

OF ANY MAGNITUDE

MADE AND ERECTED BY

GIBBONS BROTHERS LTD

DUDLEY & LONDON

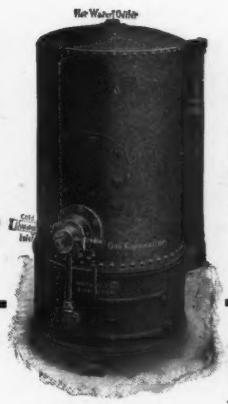
AUTOMATIC

HIGH-PRESSURE BOILER

For Delivering Hot Water to any part of a Building.

**Cast-Iron Boiler. Strong Riveted. Galvanized Steel Cistern.**

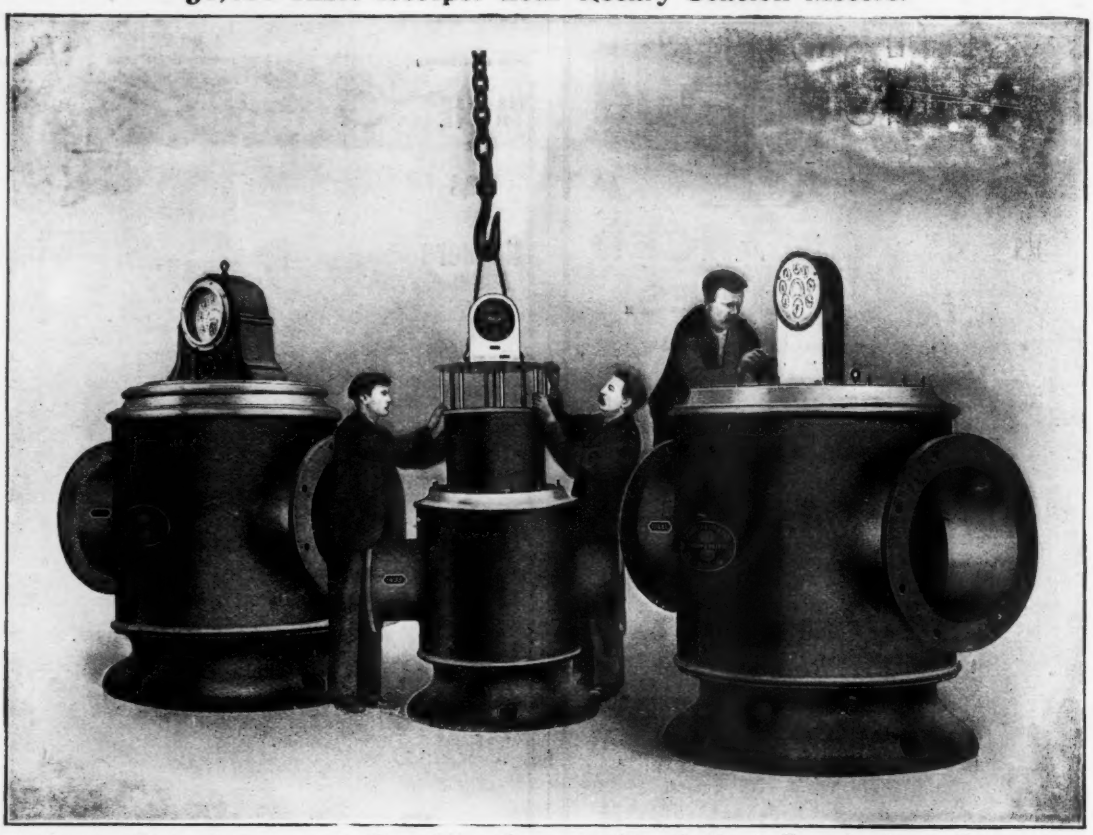
Tested to 30 lbs. to the sq. in.



**Fitted with Patent Adjustable Heat Regulator,** which automatically regulates the supply of gas as the temperature of the water varies from the desired limit.

ARDEN HILL & CO.,
CME WORKS,
STON, B'HAM.

**Putting the finishing touches to Two 60,000 cubic feet per hour and One 30,000 cubic feet per hour Rotary Station Meters.**

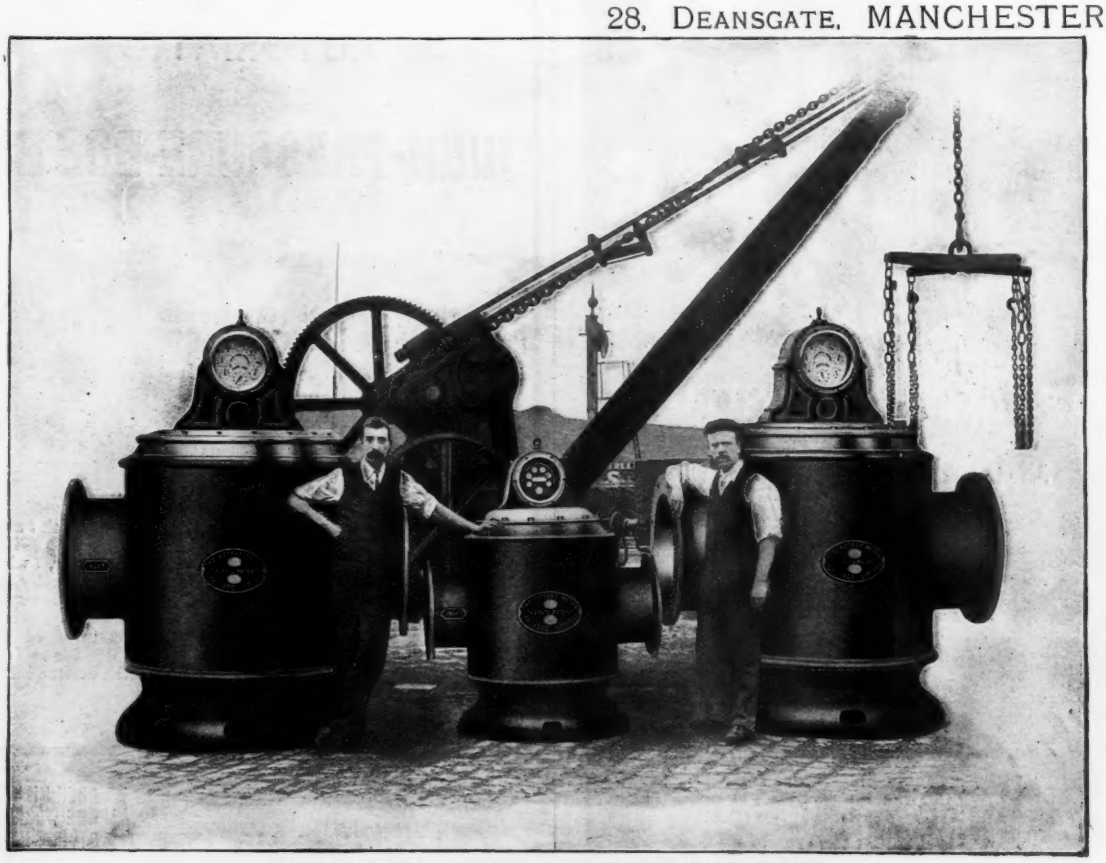


***Quotations, Drawings, and Specifications, with fullest Particulars for any size of Installation, will be forwarded on application to***

T. G. MARSH,

1, MAWSON CHAMBERS,

28, DEANSGATE, MANCHESTER.



READY FOR SHIPMENT

# MARSH AND THORP'S SPECIALITIES.

Carbonizing Foremen with anxiety to show good yield of Gas frequently increase the suction on the Retorts—Result: Air or Air and Furnace Gas is mixed with the Coal Gas. The Gas Manager with one of our Registers sees the game **AT ONCE**, and nips it in the bud.

**Arranged as EXHAUST, or EXHAUST and PRESSURE, or as PRESSURE REGISTERS.**

**PRICES.**

| | | | | | |
|---|---|---|---|---|---|
| 6 in. | Range | - - - | £8 | 10 | 6 |
| 8 in. | „ | - - - | 9 | 10 | 6 |
| 12 in. | „ | - - - | 10 | 10 | 6 |
| 15 in. | „ | - - - | 11 | 10 | 6 |
| 18 in. | „ | - - - | 13 | 13 | 0 |
| 24 in. | „ | - - - | 16 | 16 | 0 |
| 36 in. | „ | - - - | 20 | 0 | 0 |
| 50 in. | „ | - - - | 22 | 10 | 0 |

Deficiency of Pressure and variation of Pressure are the most fruitful source of Consumers' complaints.

**A Portable Register at once enables you to locate your difficulties.**

**PRICES.**

| | | | | |
|---|---|---|---|---|
| For 4 in. or 6 in. Pressure, 24 hours diagram | £7 | 0 | 0 |
| „ „ „ „ 7 days „ | 7 | 10 | 0 |
| „ 9 in. Pressure, 24 hours diagram - - | 9 | 0 | 0 |
| „ 12 in. „ „ „ - - | 10 | 10 | 0 |

No Engineer can have thorough control of his Water-Gas Plant who has not a Cycle Recorder to show what his attendants are doing.

**Marsh and Thorp's Cycle Recorder** (Patented) shows duration of Runs, Blows, Time of Coking, Time of Clinkering, and Extent of Carburation.

**It will increase the life of your Generators and Reduce the Cost of Purification.**

PRICE - - - £18 18 0

THE

## GAS & MECHANICAL SPECIALTY CO.

LIMITED,

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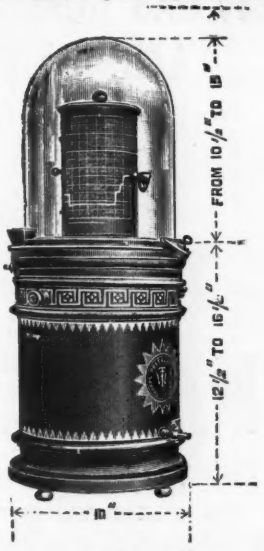
MANCHESTER.

Telephone No. 5029.
Telegraphic Address: "ROTARY, MANCHESTER."

T. G. MARSH, Managing-Director.

**Exhaust Register.**
"A little neglect may breed great mischief."




**Portable Register.**
"What is done by night appears by day."

**Water-Gas Cycle Recorders.**
"Let each part of your business have its time."

# THOMAS DUXBURY & CO.,

16, DEANSGATE, MANCHESTER.

**BEST GAS COAL AND CANNEL, GIVING HIGH ILLUMINATING POWER, LARGE YIELD PER TON, AND REASONABLE IN PRICE.**

**Gas Engineers' Agents and Contractors for**

Meters, Fire-Clay Goods, Oxide of Iron, and all other Gas Apparatus.

Retort Carbon and Spent Oxide purchased.

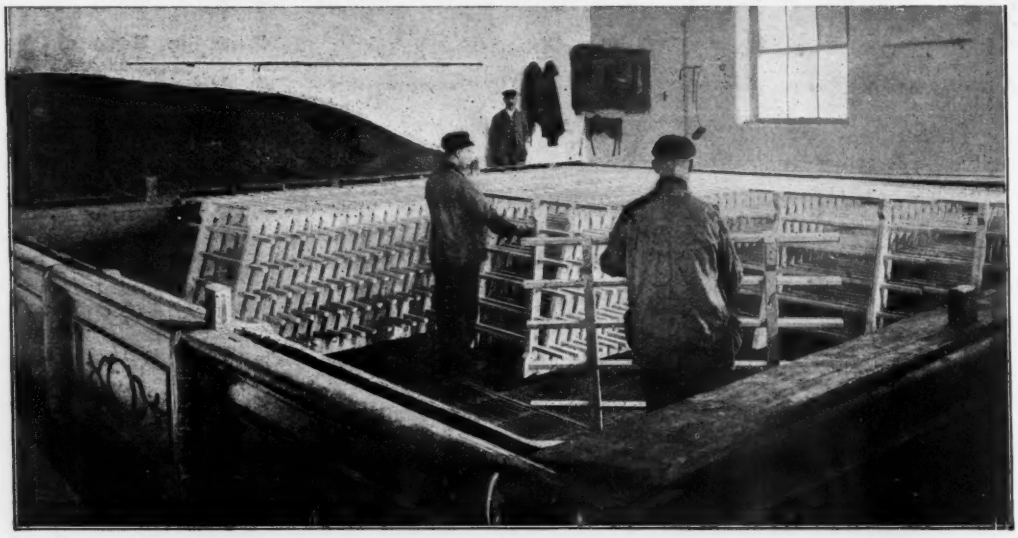
Telegrams: "DARWINIAN MANCHESTER." **ENQUIRIES SOLICITED.** Telephone 1806.

**ALL PREVIOUS RECORDS BROKEN** (*See below*)

# SPENCER'S PATENT HURDLE GRID

The very best Patent Grid on the Market for Holding Oxide Lightly.

**IT IS THE FIRST AND THE ORIGINAL DEEP GRID INVENTED.**



Can make the Change from the Old to the New System without any Stoppage.

Simple in Construction and very easy to fix in Position.

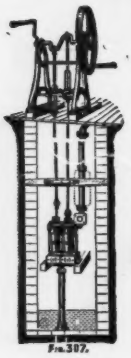
No Extra Cost in adapting this system to existing Purifiers.

They are Self-Supporting, saving the Cost of Standards and Bearers.

The first of a Set of Six Purifiers, 20 feet square, fitted with Spencer's Patent Hurdle Grids. Started Feb. 7, 1906, and run until May 27, 1907, having passed 149,266,000 feet. The Oxide was quite loose and easy to empty. Also over 300 Purifiers have been fitted with these Grids in 18 months, with Orders in hand for over 100 Sets, including nearly all the new Purifiers come out this Year. Hundreds of References can be had on application. Send for Catalogue to—

# WALTER SPENCER, GRID WORKS, ELLAND.

# JOSEPH EVANS & SONS, CULWELL WORKS, WOLVERHAMPTON.



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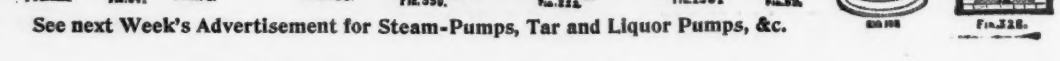

See next Week's Advertisement for Steam-Pumps, Tar and Liquor Pumps, &c.

Established 1822.
DINAS WORKS, HIRWAIN,
GLAMORGANSHIRE.
Trade Mark "ALLEN No. 1."

All Correspondence to:
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THE BEST
DINAS SILICA BRICKS
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BLOCKS FOR GAS-WORKS
Made in all shapes and sizes as desired by Engineers.

# Gas Meter Leathers

BEST QUALITY. MODERATE PRICES.

S. H. & W. HART, Tanners and Leather Manufacturers,
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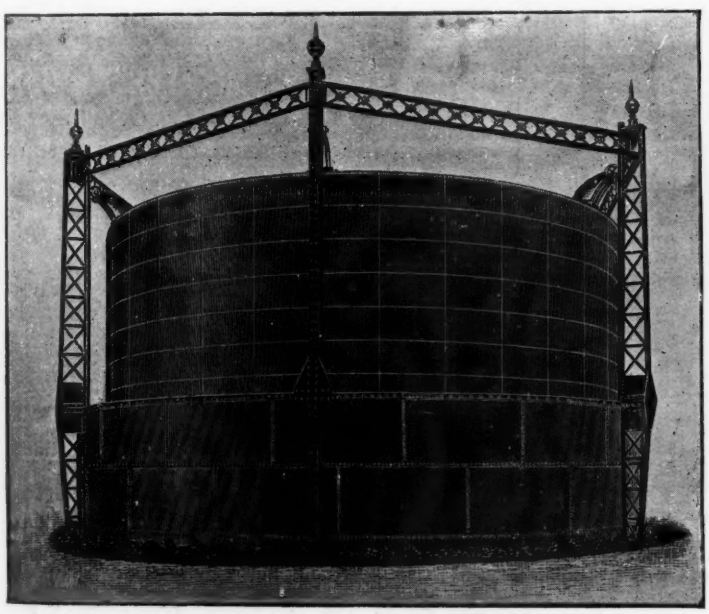
Scottish Warehouse: 7 & 9, BRUNSWICK LANE, and 148, TRONGATE, GLASGOW.



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DEWSBURY.

GASHOLDERS AND
STEEL TANKS
A SPECIALITY.

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*Plans, Specifications and Catalogues on Application.*

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EVERY DESCRIPTION of GAS APPARATUS Manufactured.

ENQUIRIES SOLICITED.

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## WET & DRY GAS METER MANUFACTURER.

# Prepayment Meters
FOR
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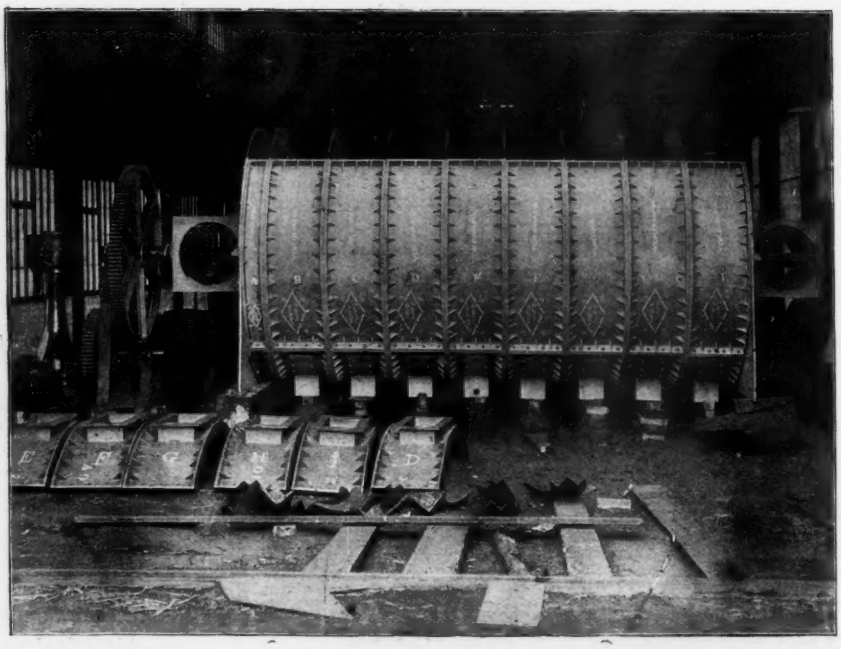
# THE WHESSOE FOUNDRY CO., LTD.
Works: DARLINGTON.

LARGE AREA OF WASHING SURFACE.

REMOVAL OF THE WHOLE OF THE AMMONIA AND A LARGE PERCENTAGE OF $CO_2$ AND $SH_2$.



SLIP OF GAS IMPOSSIBLE OWING TO OUR PATENT TELESCOPIC SLIDING JOINT.

BUNDLES EASILY ACCESSIBLE FOR CLEANING.

"Whessoe" Rotary Washer-Scrubber (H. Kirkham & Chandler's patent). Capacity 1,500,000 Cub. ft. per diem.
One of Two Machines supplied by us to a Foreign Gas-Works, photographed in our shops during course of construction.

London Office: 106, CANNON STREET E.C.

THE

# Economical Gas Apparatus Construction Co., Ld.

## 19, ABINGDON ST., WESTMINSTER, S.W., & 269, FRONT ST. E., TORONTO.

Telephone: No. 39 VICTORIA.

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**J. T. WESTCOTT,** *Managing-Director.*

# CARBURETTED & BLUE WATER-GAS PLANTS,

MERRIFIELD-WESTCOTT-PEARSON PATENTS.

**The above Company have erected or are now erecting, their Universal Type of Plants at the following Gas-Works :—**

| | Cub. Ft. Daily. | | Cub. Ft. Daily. |
|---|---|---|---|
| BLACKBURN | 1,250,000 | STRETFORD | 500,000 |
| WINDSOR ST. WORKS, BIRMINGHAM | 2,000,000 | OLDBURY | 300,000 |
| SALTLEY WORKS, BIRMINGHAM | 2,000,000 | TODMORDEN | 500,000 |
| COLCHESTER | 300,000 | SALTLEY, BIRMINGHAM (3rd Cont.) | 2,000,000 |
| BIRKENHEAD | 2,250,000 | YORK (Second Contract) | 750,000 |
| DEVIZES | 120,000 | ROCHESTER (Second Contract) | 500,000 |
| SALTLEY, BIRMINGHAM (Second Contract) | 2,000,000 | NEWPORT (MON.) | 250,000 |
| WINDSOR ST., BIRMINGHAM (Second Contract) | 2,000,000 | TOKIO, JAPAN | 1,000,000 |
| HALIFAX | 1,000,000 | NEWCASTLE-ON-TYNE | 1,800,000 |
| TORONTO | 250,000 | LEEDS | 1,800,000 |
| OTTAWA | 250,000 | MALTON | 150,000 |
| LINDSAY (Remodelled) | 125,000 | SMETHWICK | 500,000 |
| MONTREAL | 500,000 | GRAVESEND | 300,000 |
| TORONTO (Second Contract Remodelled) | 2,000,000 | PERNAMBUCO (BRAZIL) | 125,000 |
| BELLEVILLE | 250,000 | DULUTH (Second Contract) | 300,000 |
| OTTAWA (Second Contract) | 250,000 | LEICESTER (Second Contract) | 1,000,000 |
| BRANTFORD (Remodelled) | 200,000 | NEWPORT, MON. (Second Contract) | 250,000 |
| ST. CATHERINES (Remodelled) | 250,000 | BROCKVILLE | 250,000 |
| KINGSTON, PA. | 125,000 | TORONTO (Third Contract) | 750,000 |
| PETERBOROUGH, ONT. | 250,000 | MONTREAL, ONT. (Second Contract) | 1,800,000 |
| WILKESBARRE, PA. | 750,000 | TORONTO (Fourth Contract) | 1,000,000 |
| ST. CATHERINES (Second Contract) | 250,000 | HAMILTON, ONT. | 400,000 |
| BUFFALO, N.Y. | 2,000,000 | ROCHESTER (Third Contract) | 1,600,000 |
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| KINGSTON, ONT. | 300,000 | ROCHDALE | 1,600,000 |
| SOUTH SUBURBAN GAS COMPANY (late Crystal Palace District) | 2,000,000 | ST. JOHN'S, NEWFOUNDLAND | 250,000 |
| DULUTH, MINN. | 300,000 | BRANTFORD (Second Contract) | 400,000 |
| CATERHAM | 150,000 | SMETHWICK (Second Contract) | 500,000 |
| LEICESTER | 2,000,000 | PONTYPRIDD | 250,000 |
| ENSCHEDE (HOLLAND) | 150,000 | MONTREAL (Third Contract) | 1,800,000 |
| BUENOS AYRES (RIVER PLATE CO.) | 700,000 | GUELPH, ONT. | 350,000 |
| BURNLEY | 1,500,000 | BUENOS AYRES (RIVER PLATE CO.) (Second Contract) | 750,000 |
| KINGSTON-ON-THAMES | 1,750,000 | BELGRANO (RIVER PLATE CO.) | 500,000 |
| ACCRINGTON | 500,000 | QUEBEC | 250,000 |
| TONBRIDGE | 300,000 | AUCKLAND, N.Z. | 150,000 |
| | | TORONTO (Fifth Contract) | 2,000,000 |
| | | VANCOUVER, B.C. | 800,000 |

**Also COAL-GAS PLANTS at**

NELSON (B.C.), CHATHAM, NAPANEE, OWEN SOUND, CALGARY, WINNIPEG, and WINNIPEG (2nd).

**And additional work consisting of Consulting Engineering, Gasholders, Purifiers, Condensers, &c.**

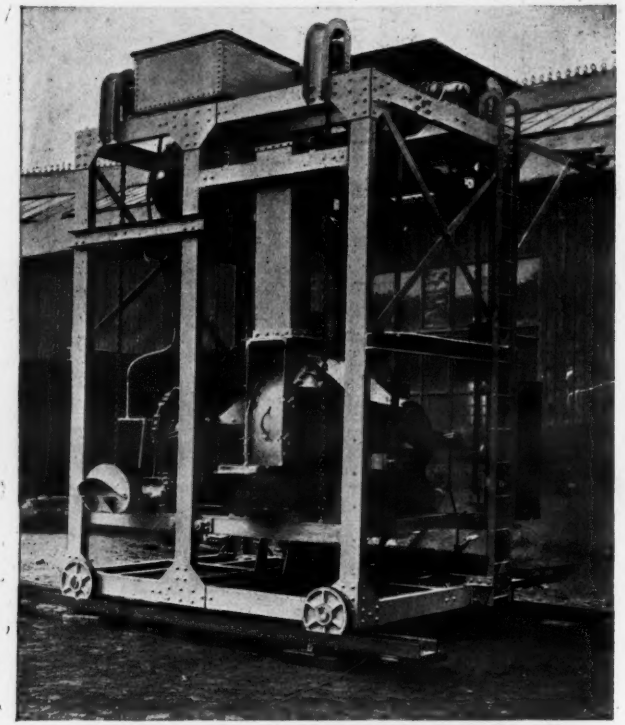
# ROBERT DEMPSTER & SONS, LD., ELLAND.

## UP-TO-DATE

## RETORT-HOUSE MACHINERY.

**NO NUISANCE FROM FLAME, DUST, OR SMOKE.**

**COAL from Dust up to 3 in. Cube may be used.**



Combined Machine in Operation at BINGLEY.

**OUR PATENT**

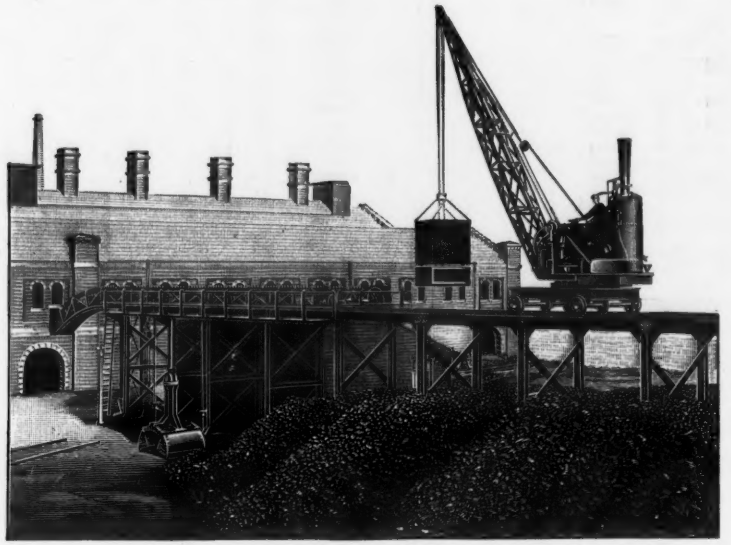
## HOT COKE CONVEYORS

Have the longest lifetime of any on the Market.

**INSPECTION INVITED**

To Installations erected by us at

**SHREWSBURY, ACCRINGTON, & STOCKPORT.**



Hot Coke Conveyor erected at the Great Harwood Gas-Works.

## COKE HOPPERS, SCREENS, & COAL HANDLING PLANTS.

# HUMPHREY LAMPS.

## THE ORIGINAL GAS ARCS.

35 STYLES and SIZES
for all positions.

INDOORS and OUTDOORS.

THE ABSOLUTE STANDARD.

THEY LEAD—OTHERS TRY TO FOLLOW.

The Outdoor Lamp for Shop Fronts, 2, 3, and 4 Burners.

All HUMPHREY LAMPS can be controlled automatically from any distance.

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and all Factors in Great Britain.

*Illustrated Lists and Information Free.*

Nickel or Enamel Cylinder Indoor Lamp, 2, 3, 4, and 6 Burners.

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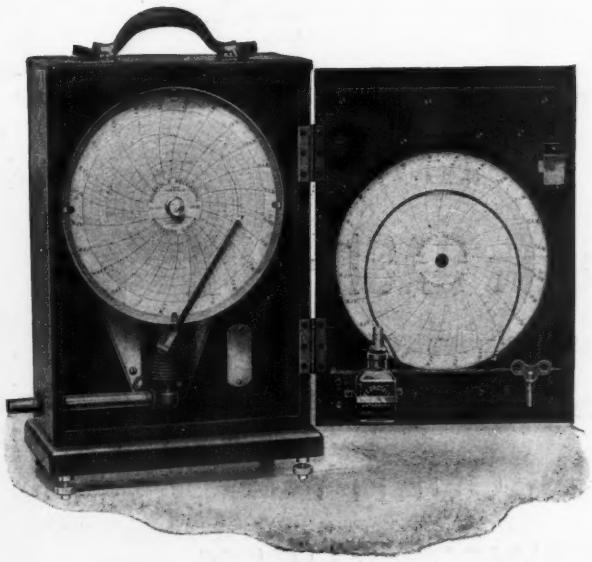
# NEW PORTABLE RECORDING GAUGES

For Pressure, Vacuum, or Combination Pressure and Vacuum.



OVER 500 RANGES TO MEET ALL REQUIREMENTS.

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# GEORGE ORME & CO.

ATLAS METER WORKS, (BRANCH OF METERS LIMITED),

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## "NEW CENTURY" IMPROVED PATENT COIN PREPAYMENT GAS-METERS

**FITTED WITH DETACHABLE ATTACHMENTS.**

**ARRANGED FOR 1d., 6d., 1s., OR ANY OTHER COIN DESIRED.**

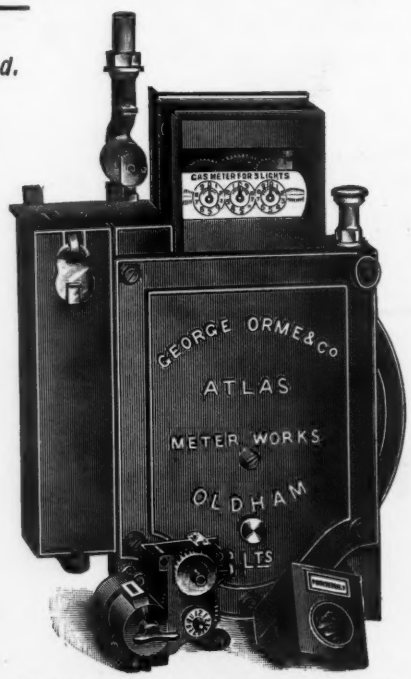
*These Meters are giving Universal Satisfaction wherever adopted.*

**Guaranteed for Five Years.**

Dry Meter in Tin-Plate Case, fitted with Attachment.

Price changed *in situ* by means of one Crown Wheel only.

COMPACT,
DURABLE,
RELIABLE,
SIMPLE.




Wet Meter in Cast-Iron Case, with Attachment Removed.

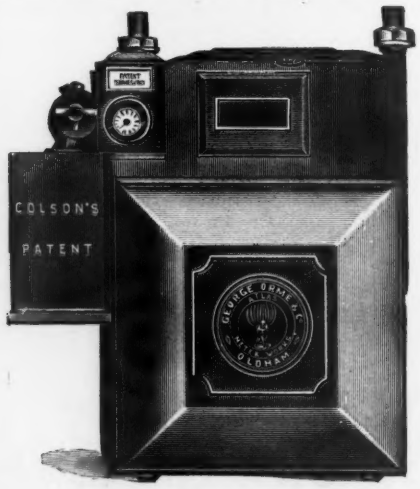
Meters fitted with

## COLSON'S PATENT CASH-BOX

(AS ILLUSTRATED)

ENSURES

ABSOLUTE SECURITY
AGAINST THEFT.

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# "BRAY" BURNERS

## FOR SEASON 1907-8.

**This Burner ☛ gives 24 Candles per cubic foot of Gas WITHOUT A CHIMNEY.**

**A low-priced burner equal in lighting power, economy, and efficiency, to the highest-priced burner on the market.**

THE "BRAY" '07 "C." BURNER.

**Irish International Exhibition.**

**GAS PAVILION, STAND 703.**

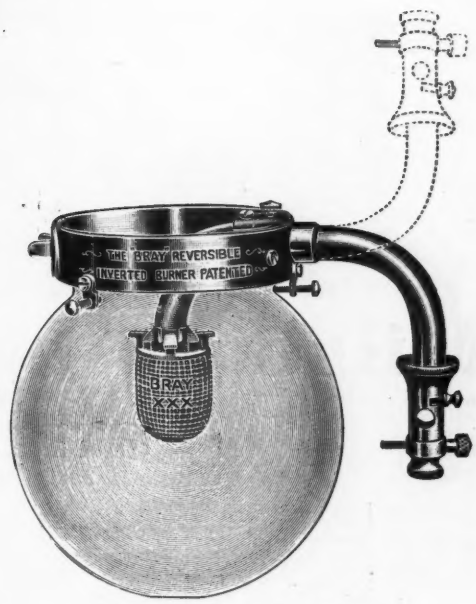
**Constructed so that the vital parts can be INSTANTLY CLEANED without removing the mantle or glassware.**

THE "BRAY" '07 V.I.

This Burner possesses the advantage that the surface of the earthenware deflector is readily accessible for cleaning without removing the globe. The deflector, having an extra wide flange, also acts as a reflector.

Fitted with Patent Spring Globe Holder, as is the "Bray" '07 R. I.

THE "BRAY" '06 "C."




THE "BRAY" '07 R. I. No. 3.

This Burner is made in two sizes—viz., No. 3 to consume 3 cubic feet of gas per hour, and No. 2 to consume 1½ cubic feet.

It fits any style of Gas Bracket, old or new, no adapter being required.

Fitted with a Patent Spring Globe Holder, which obviates broken globes, and facilitates the removal of globe for cleaning, or for renewing the mantle.

Cannot discolour gasfittings.

High Lighting Power.

Low Gas Consumption.

**WRITE FOR PRICE LIST.**

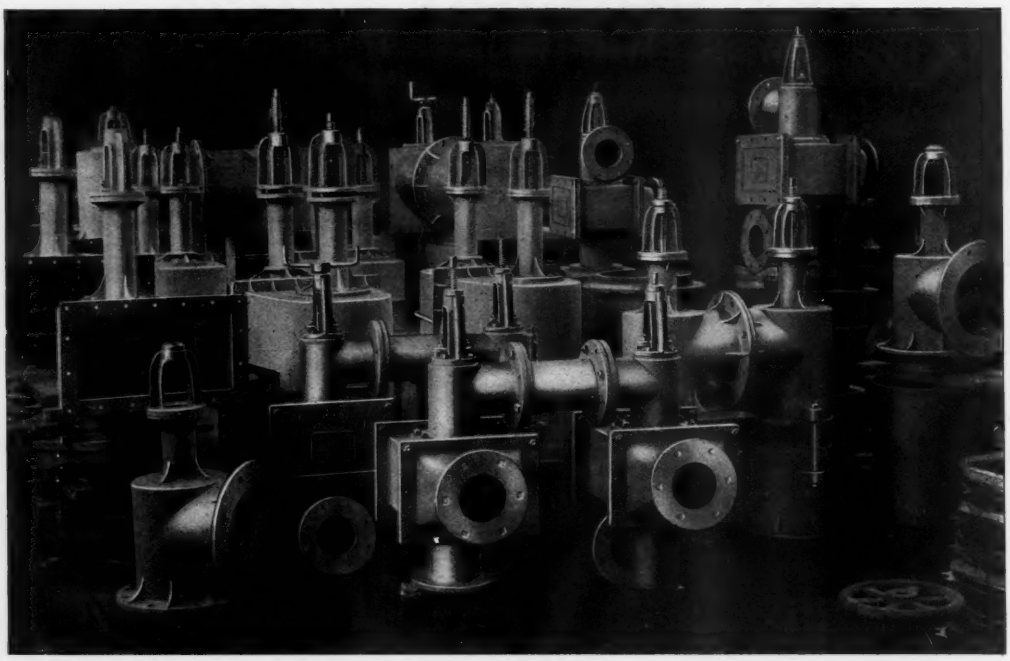
# GEO. BRAY & CO., LIMITED. Gas Lighting Engineers, LEEDS.

**London Office—17, FARRINGDON STREET, E.C.** **Telephone 842 HOLBORN.**

# Gasholders

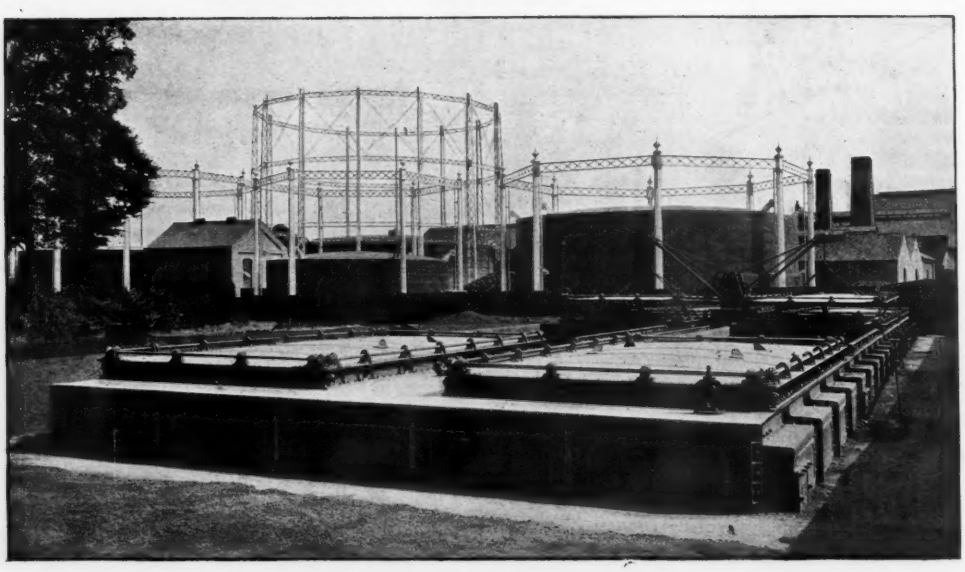
Steel or other Tanks, with Guide Framing or Columnless.

**GAS PLANT OF EVERY DESCRIPTION DESIGNED AND ERECTED.**



Group of Valves in Erecting Shop at Works before Despatch.

# Milbourne's Patent Purifiers and Valves.



Set of Four Milbourne's Patent Purifiers.

**SOLE MAKERS:**

**C. & W. WALKER, LTD.,**

**MIDLAND IRON WORKS, DONNINGTON, NEWPORT, SALOP.**

**110, CANNON STREET, LONDON, E.C.**

# A THOROUGH SUCCESS.

## DR. ROSTIN'S APPARATUS

For AUTOMATICALLY

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## FACTS SPEAK FOR THEMSELVES.

SAVING EFFECTED OF FROM

**4s. to 13s.**

per LAMP per ANNUM.

The only system able to deal with any conditions of pressure. Varying gradients absolutely immaterial.

Perfectly simultaneous Lighting of all Lamps, however large the Installation.

TRY FOR YOURSELF.

No Payment required if statements are incorrect.

See our large Installations at Tottenham, Westminster, and Lambeth.

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THE

# DELLWIK-FLEISCHER WATER GAS PROCESS.

**Blue Water Gas. Carburetted Water Gas. Self-Carburetting.**

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BERLIN—Dantziger Strasse
BERLIN—Gitschiner Strasse
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BILSTON
BERNE (Switzerland)
BEYRUTH (Syria)
BARKING
BRUMMEN (Holland)
BRUMMEN, 2nd Order
CAPE TOWN (South Africa)
CLEETHORPES
CLEETHORPES, 2nd Order
CHEMNITZ (Germany)
CWMBRAN
DORTMUND (Germany)
DRESDEN (Germany)
ERLANGEN (Germany)
ERFURT (Germany)
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FREIBERG (Saxony)
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GÜSTROW (Germany)
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KÖNIGSBERG (Germany)
LÜDVIGSHAFEN (Germany)
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LYON, 2nd Order
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MARSEILLES (France)
MARSEILLES, 2nd Order
NUREMBERG (Germany)
NUREMBERG, 2nd Order
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OSTERFELD (Germany)
OSNABRÜCK (Germany)
PFORZHEIM (Germany)
PLAUEN (Germany)
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REGENSBERG (Germany)
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ROME (Italy)
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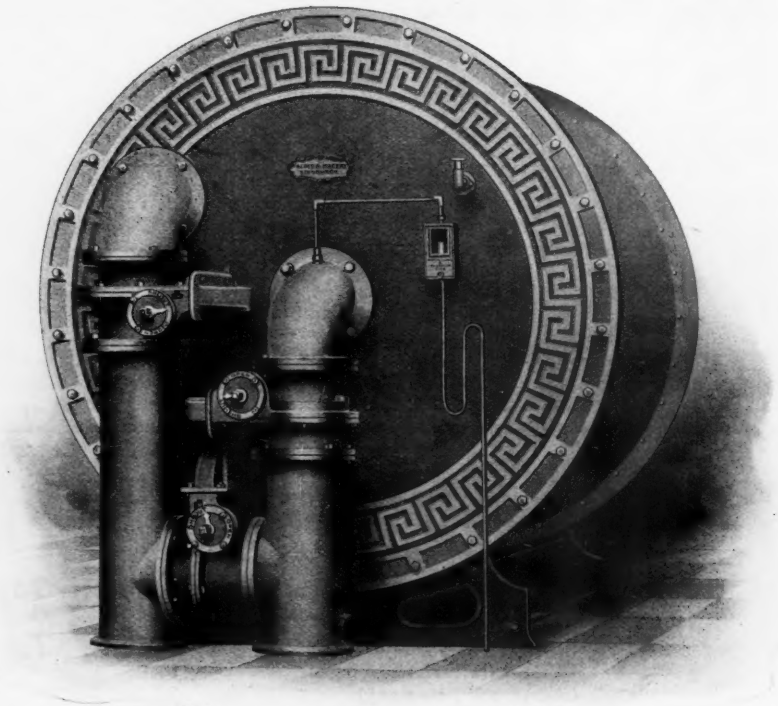
## STATION GAS METERS

**In Cylindrical and Rectangular Cases of the most improved Design.**



Station Meter in Cylindrical Case with Bye-Pass of Three Slide-Valves.

**Patentees and Manufacturers of**

## PRESSURE CONTROLLED LIGHTING AND EXTINGUISHING APPARATUS FOR STREET LIGHTING, &c.

## HURRICANE PROOF STREET LANTERNS

**Of Unequalled Efficiency.**

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**Dry Meters in Tinplate Cases.**
**Dry Meters in Cast Iron Cases.**
**Dry Prepayment Meters.**

Large Dry Meter in Heavy Tinned Iron Plates.

**Wet Meters in Cast Iron Cases.**
**Wet Prepayment Meters.**
**Wet Underground Meters.**

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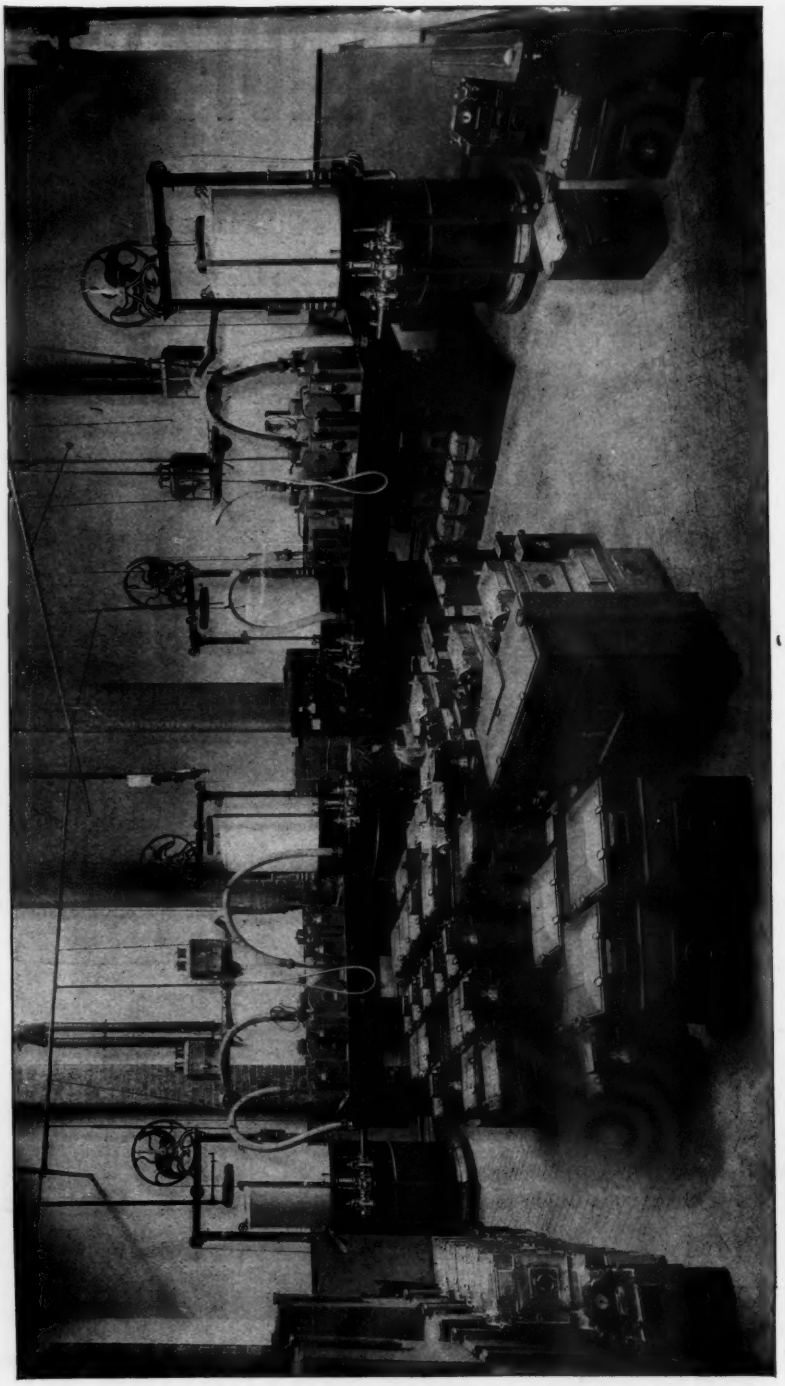
# THE GAS METER COMPANY, LIMITED.

Consumers' and Station Meters, Pressure Gauges, &c., &c.



TEST HOLDER INSTALLATION

RECENTLY SUPPLIED TO THE CITY OF LONDON CORPORATION.

**Works: LONDON, OLDHAM, DUBLIN, MANCHESTER.**

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| Telegrams: | "Meter, London." | "Meter, Oldham." | "Meter, Dublin." | "Meter, Manchester." |

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**Gas Engineers and Chemical Plumbers,**

**13, CROSS STREET, FINSBURY, LONDON, E.C.,**

AND AT

**HAMPDEN WORKS, NEW SOUTHGATE, N.**

## SULPHATE OF AMMONIA PLANTS

*A SPECIALITY.*

Photo. of a Corner of our Lead Burning Workshop at New Southgate.

# COAL TAR PRODUCTS.

**Benzol, Toluol, Solvent Naphtha, Creosote Oils, Grease Oils, Carbolic Acid, Crude Creosote Salts, Granulated (Crude) and Sublimed Naphthalene, Anthracene, Refined Tar and Pitch. Sulphate of Ammonia up to 20·75 per cent. Nitrogen.**

For Prices apply to the **SOUTH METROPOLITAN GAS COMPANY,**

Works: ORDNANCE WHARF, EAST GREENWICH, LONDON, S.E.

**709, OLD KENT ROAD, LONDON, S.E.**

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No. 8505.

# GAS FITTINGS

**of every description for Inverted or Ordinary Incandescent Lighting.**

BURNERS, MANTLES, GLOBES, AND ALL ACCESSORIES.

OUTSIDE GAS LAMPS, ARC LAMPS, METERS, COLUMNS, &c.

**Re-lacquering and Re-bronzing in the best manner at lowest prices.**

**D. HULETT & Co., LTD., GAS ENGINEERS,**

**55 & 56, HIGH HOLBORN, LONDON.**

# O'NEILL'S OXIDE

**SUPPLIED ON LOAN OR PURCHASE.**

SPENT OXIDE BOUGHT IN ANY DISTRICT.

## GAS PURIFICATION & CHEMICAL CO., LTD.,

Telegrams: "PURIFICATION LONDON." **PALMERSTON HOUSE, LONDON, E.C.** Telephone: LONDON WALL 9144.

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EVERITT'S

## PATENT TAR-EXTRACTOR

**As a Naphthalene Remover.**

The Exhaust Steam heats up the Tar and the Gas, and enables it to remove the maximum amount of Naphthalene. By removing the Tar, no Naphthalene is carried forward to the Scrubbers, except in strong and thorough combination with an **EXCESS** of light hydrocarbons, so evenly distributed and always sufficient in quantity to prevent the action of ammonia on the phenols liberating the Naphthalene dissolved by them.

**SOLE MAKERS:**

**ROBERT DEMPSTER & SONS,**

ROSE MOUNT IRON-WORKS, *LTD.*,

**ELLAND, Yorks.**

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## LEAD WOOL JOINTS

are

## 25% CHEAPER AND 250% STRONGER

than

## CAST LEAD JOINTS.

Particulars, Sample, and Quotation from

**THE LEAD WOOL COMPANY,**

**SNODLAND, KENT.**

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## ARROL-FOULIS

**Patent Automatic Machinery**

**FOR**

## DRAWING AND CHARGING GAS-RETORTS.

**Full Particulars may be obtained from the Sole Makers,**

**SIR WILLIAM ARROL & CO., Limited,**

**GLASGOW.**

**[See Illustrated Advertisement, June 11, p. 768.]**

---

**"VITERNUS"** FOR

## PAINT GASHOLDERS.

Makers: JOHN E. WILLIAMS & CO., *Lower Moss Lane,* MANCHESTER, S.W.

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No. 11.

No. 12.

## GOVERNORS

**FOR**

## Incandescent Burners.

By regulating the Gas supply a better flame is obtained, the Light improved, Gas saved, and less wear and tear of the Mantle.

**No. 11, Heavy Pattern, 15s. per doz.**

**No. 12, Medium Pattern, 12s. per doz.**

SUBJECT TO DISCOUNT.

## THE GAS APPARATUS COMPANY,

PETERBOROUGH, ENGLAND.

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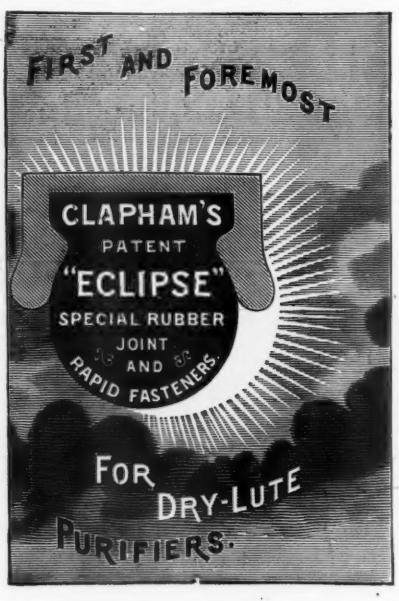
OVER 3½ MILES ORDERED.

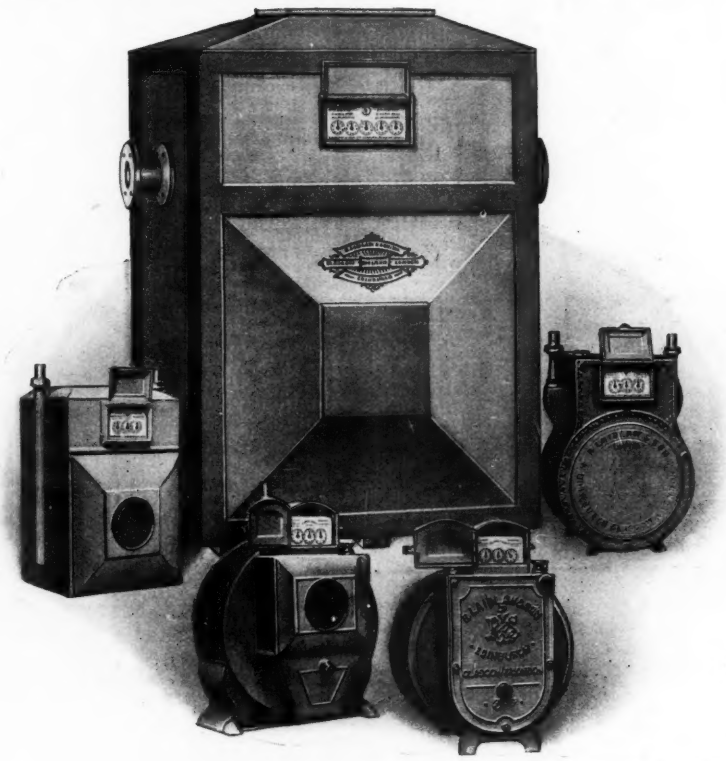



CLAPHAM BROS., LTD., KEIGHLEY.

# R. LAIDLAW & SON

— LIMITED —

## GAS METER MAKERS.



Ordinary Dry Gas Meters in Tin Plate Cases (150 Lights & upwards Panelled).

Ordinary Dry Gas Meters in Cast-Iron Cases.

Wet Gas Meters in Tin Plate and Cast-Iron Cases.

All made of best Materials and Workmanship.

## PREPAYMENT METERS.

Thousands of our Meters in use by the largest Gas Companies and Corporations and giving complete satisfaction.

SIMON SQUARE WORKS, EDINBURGH.

ALLIANCE FOUNDRY, GLASGOW.

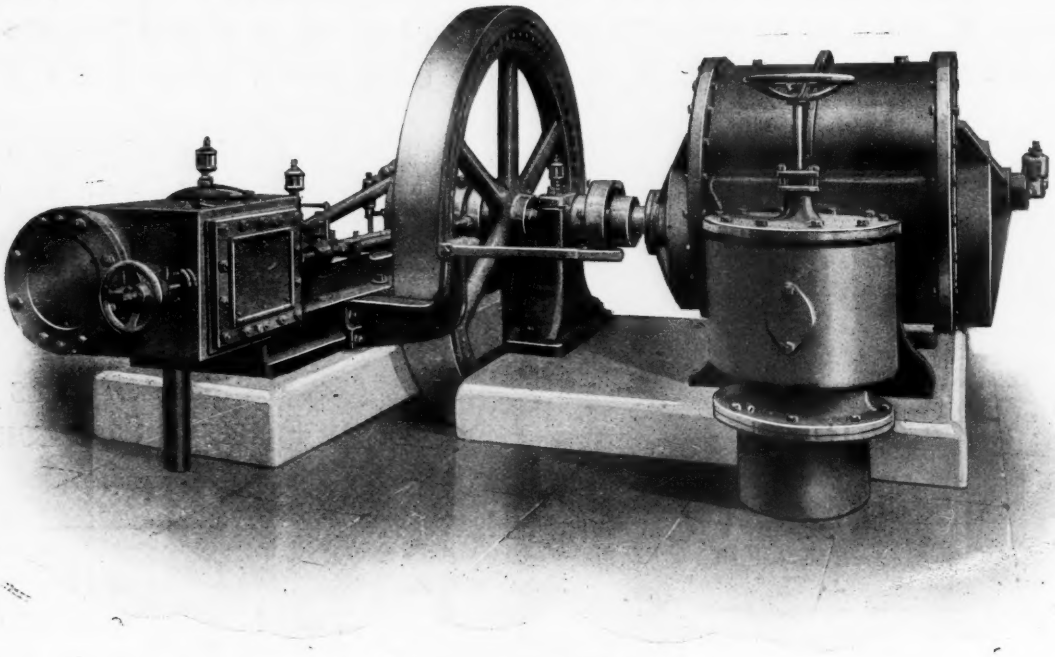
6, LITTLE BUSH LANE, LONDON, E.C.

# EXHAUSTING MACHINERY.

## ORIGINAL MAKERS OF WALLER'S 3 & 4 BLADE EXHAUSTERS

**Over 1200 supplied—from 500 to 500,000 cubic feet per hour.**

**Slow Speed, Steady Gauge, Small Steam Consumption, Suitable for High Pressures.**



## COKE BREAKING

**PLANTS, with or without Elevators, Screens, Hoppers, &c.**

## GAS VALVES

**of all sizes and descriptions.**

## PUMPS

**for Tar, Liquor, and Water.**

## "PINKNEY" GAS ENGINES.

**Small Power Units. High Efficiency. Best Design.**

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**(Sole Makers for Great Britain).**

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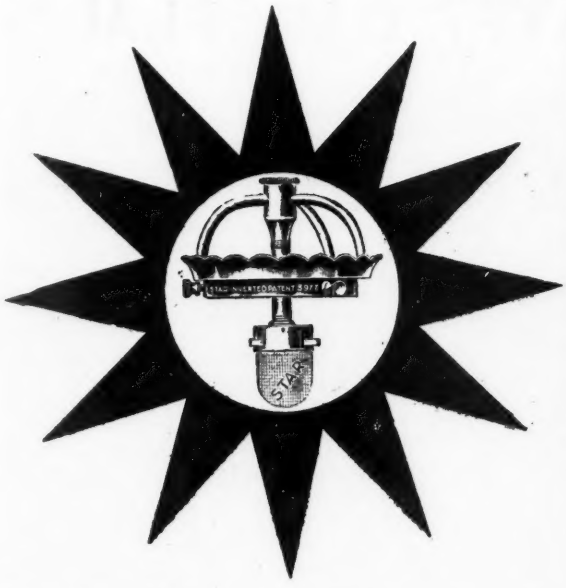
# THE BURNER WITH A REPUTATION.



## A Brilliant Success.

*See Article in "Gas Journal," Aug. 28, 1906, p. 570.*

**Send for Illustrated Price List.**

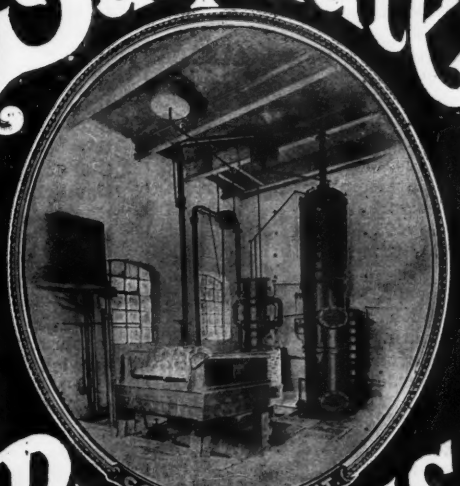
In open competition with all the well-known Burners, the No. 2 "STAR" has been adopted after the most exhaustive tests by the Corporation for Lighting the Streets of Edinburgh.

**THE "STAR" INVERTED INCANDESCENT BURNER CO., LTD.,**

*104-105, GREAT SAFFRON HILL, LONDON, E.C.*

LESS FUEL — First Class Work. — BEST COLOUR

# Sulphate PLANTS

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ASHMORE, BENSON, PEASE & Co. LTD. STOCKTON ON TEES.

Telg. "Gasholder."

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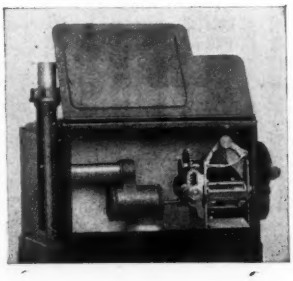

SIMPLEX MECHANISM & VALVE.

LOW PRICE.
BEST MATERIAL & WORKMANSHIP.
SIMPLICITY of MECHANISM.
DEFECTS REDUCED to a MINIMUM.

**METROPOLITAN GAS-METERS, LTD.,**

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RISE AND FALL

# Gas Pendant.

PATENTED EVERYWHERE.

WITH

**The "Harquin" PATENT CONNECTION FOR METALLIC TUBING.**

When closed up 2 ft. over all.
When pulled down 5 ft. 6 in. over all.

**NO LEAKS.**

It gives a variation in length of 3 ft. 6 in.

*Patentees and Manufacturers,*
**THE "HARQUIN" PENDANT CO.**
(Dept. W.)

No moving joint in body. Direct supply from Main to Tap.

No unsightly counter-weight or danger of same falling.

Easily adjusted to take shades or fittings of different weights.

**NO LEAKS.**

The nearest approach to Electric Light in Appearance, Utility, and Adjustability.

**136 & 138, Kentish Town Road,**
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## CARBURETTED-WATER-GAS PLANT.

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| Agram, Croatia | 200,000 |
| Alkmaar, Holland | 400,000 |
| Antwerp, Belgium | 1,500,000 |
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| Aylesbury | 150,000 |
| Barrow | 300,000 |
| Bath | 1,000,000 |
| Belfast | 1,700,000 |
| Belfast (Second) | 4,500,000 |
| Berlin—Charlottenburg | 2,500,000 |
| Berlin—Rixdorf | 650,000 |
| Birmingham | 1,500,000 |
| Bochum, Westphalia | 530,000 |
| Bognor | 100,000 |
| Bordentown, N.J. | 125,000 |
| Bournemouth | 1,000,000 |
| Bournemouth (Second) | 500,000 |
| Bremen, Germany | 550,000 |
| Bremen, Germany (Second) | 950,000 |
| Brentford | 1,200,000 |
| Bridgwater | 200,000 |
| Bridlington | 150,000 |
| Bridlington (Second) | 200,000 |
| Brieg, Silesia | 100,000 |
| Brighton | 1,750,000 |
| Brighton (Second) | 1,850,000 |
| Bruges, Belgium | 200,000 |
| Brussels—Anderlecht | 350,000 |
| Brussels—Forest | 1,000,000 |
| Brussels—St. Josse | 1,000,000 |
| Brussels—Ville | 750,000 |
| Brussels—Ville (Second) | 750,000 |
| Brussels—Ville (Third) | 1,500,000 |
| Brussels—Ville (Fourth) | 350,000 |
| Budapest, Hungary | 50,000 |
| Carlisle | 600,000 |
| Chorley | 300,000 |
| Commercial Gas Co. | 850,000 |
| Commercial (Second) | 850,000 |
| Commercial (Third) | 1,250,000 |
| Commercial (Fourth) | 2,000,000 |
| Copenhagen | 700,000 |
| Copenhagen (Second) | 2,500,000 |
| Coventry | 600,000 |
| Coventry (Second) | 600,000 |
| Croydon | 1,250,000 |
| Croydon (Second) | 625,000 |
| Croydon (Third) | 625,000 |
| Deventer, Holland | 150,000 |
| Deventer, Holland (Second) | 200,000 |
| Dorking | 150,000 |
| Dublin | 2,000,000 |
| Dublin (Second) | 2,000,000 |
| Dublin (Third) | 650,000 |
| Dundee | 1,500,000 |
| Dunedin, N.Z. | 150,000 |
| Dunedin, N.Z. (Second) | 275,000 |
| Durham | 200,000 |
| Eastbourne | 1,250,000 |
| Edinburgh | 2,000,000 |
| Epsom | 225,000 |
| Falmouth | 150,000 |
| Faversham | 200,000 |
| Flensburg, Sleswig | 300,000 |
| G. L. & C. Co., Beckton | 2,250,000 |
| G. L. & C. Co., „ (2nd) | 10,750,000 |
| G. L. & C. Co., Bromley | 3,750,000 |
| G. L. & C. Co., Fulham | 1,750,000 |
| G. L. & C. Co., Nine Elms | 2,750,000 |
| Geneva, Switz. | 500,000 |
| Gosport | 200,000 |
| Göteborg, Sweden | 300,000 |
| Guildford | 350,000 |
| Hamburg, Germany | 1,750,000 |
| Hampton Court | 500,000 |
| Hartlepool | 750,000 |
| Hebden Bridge | 200,000 |
| Heidelberg, Germany | 200,000 |
| Holyoke, Mass. | 600,000 |
| Hull | 1,500,000 |
| Innsbruck, Austria | 200,000 |
| Ipswich | 750,000 |
| L. & N.W. Rly., Crewe | 700,000 |
| Lawrence, Mass. | 400,000 |
| Lea Bridge | 350,000 |
| Lea Bridge (Second) | 350,000 |
| Lea Bridge (Third) | 400,000 |
| Leeuwarden, Holland | 400,000 |
| Leiden, Holland | 500,000 |
| Leigh, Lancs. | 350,000 |
| Lemberg, Galicia | 260,000 |
| Liége, Belgium | 1,000,000 |
| Liége, Belgium (Second) | 750,000 |
| Lincoln | 500,000 |
| Liverpool | 3,500,000 |
| Liverpool (Second) | 4,500,000 |
| Longton | 600,000 |
| Maastricht, Holland | 200,000 |
| Magdeburg, Germany | 1,400,000 |
| Maidenhead | 225,000 |
| Maidenhead (Second) | 225,000 |
| Malmö, Sweden | 350,000 |
| Malta | 400,000 |
| Manchester | 3,500,000 |
| Manchester (Second) | 3,500,000 |
| Marlborough | 100,000 |
| McKeesport, Pa. | 500,000 |
| Merthyr Tydfil | 300,000 |
| Middlesbrough | 1,250,000 |
| Newburgh, N.Y. | 350,000 |
| Newburgh (Second) | 250,000 |
| New York | 1,200,000 |
| New York | 4,000,000 |
| North Middlesex | 150,000 |
| North Middlesex (Second) | 200,000 |
| North Middlesex (Third) | 75,000 |
| Norwich | 1,000,000 |
| Nuneaton | 125,000 |
| Oberhausen, Germany | 175,000 |
| Ostend, Belgium | 100,000 |
| Perth, W.A. | 125,000 |
| Poole | 1,500,000 |
| Port Elizabeth, S.A. | 400,000 |
| Portsmouth | 1,000,000 |
| Posen, Germany | 450,000 |
| Posen, Germany (Second) | 700,000 |
| Preston | 1,400,000 |
| Reading | 1,000,000 |
| Redhill | 275,000 |
| Redhill (Second) | 300,000 |
| Reichenberg, Bohemia | 200,000 |
| Romford | 300,000 |
| Rotterdam, Holland | 850,000 |
| Rotterdam, Holland (Second) | 1,500,000 |
| Rotterdam, Holland (Third) | 750,000 |
| St. Gallen, Switz. | 225,000 |
| St. Gallen, Switz. (Second) | 225,000 |
| St. Joseph, Mo. | 750,000 |
| Santiago de Cuba | 400,000 |
| Scarborough | 800,000 |
| Shanghai | 225,000 |
| Shanghai (Second) | 225,000 |
| Southampton | 800,000 |
| Southampton (Second) | 500,000 |
| Southgate | 400,000 |
| Southport | 750,000 |
| Southport (Second) | 900,000 |
| Stafford | 500,000 |
| Staines | 600,000 |
| Stockholm | 1,500,000 |
| Stockport | 600,000 |
| Stockport (Second) | 600,000 |
| Stockport (Third) | 400,000 |
| Stockton-on-Tees | 500,000 |
| Swansea | 750,000 |
| Swansea (Second) | 1,000,000 |
| Swindon | 300,000 |
| Sydney—Harbour | 500,000 |
| Sydney—Harbour (Second) | 500,000 |
| Sydney—Mortlake | 500,000 |
| Sydney—Mortlake (Second) | 500,000 |
| Syracuse, N.Y. | 850,000 |
| Taunton | 225,000 |
| Taunton (Second) | 350,000 |
| The Hague, Holland | 1,000,000 |
| The Hague, Holland (Second) | 500,000 |
| Tilburg, Holland | 400,000 |
| Tottenham | 750,000 |
| Tottenham (Second) | 750,000 |
| Tottenham (Third) | 350,000 |
| Tottenham (Fourth) | 1,000,000 |
| Tottenham (Fifth) | 1,000,000 |
| Tunbridge Wells | 1,000,000 |
| Utrecht, Holland | 1,000,000 |
| Utrecht, Holland (Second) | 1,000,000 |
| Vienna | 3,500,000 |
| Waltham | 400,000 |
| Wandsworth & Putney | 1,800,000 |
| Watford | 300,000 |
| Watford (Second) | 350,000 |
| West Ham | 1,500,000 |
| West Ham (Second) | 800,000 |
| Weston-super-Mare | 350,000 |
| Wexford, Ireland | 100,000 |
| Winchester | 225,000 |
| Winchester (Second) | 125,000 |
| Zwolle, Holland | 200,000 |
| Zwolle, Holland (Second) | 200,000 |

### AND WORK UNDERTAKEN SINCE JANUARY 1, 1906.

| | | | | | |
|---|---|---|---|---|---|
| Romford (2nd) | 350,000 | Bishop's Stortford | 200,000 | Maidstone | 500,000 |
| Cracow, Galicia | 200,000 | Berlin-Tegel | 3,500,000 | Nelson | 400,000 |
| Berlin-Rixdorf (2nd) | 700,000 | San Paulo, Brazil | 700,000 | Brussels—St. Gilles | 1,000,000 |
| Mayence, Germany | 700,000 | Reval, Russia | 350,000 | Barmen-Rittershausen | 500,000 |
| Guildford (2nd) | 200,000 | Gelsenkirchen, Westphalia | 175,000 | Rotterdam (5th) | 600,000 |
| Kiel, Sleswig | 1,000,000 | Graudenz, West Prussia | 200,000 | Shanghai (3rd) | 1,600,000 |
| Chigwell | 350,000 | Schwelm, Westphalia | 100,000 | Carlsruhe, Germany | 500,000 |
| Rotterdam (4th) | 750,000 | Hong Kong | 450,000 | Stockholm (2nd) | 1,750,000 |
| Haarlem, Holland | 850,000 | Kampen, Holland | 350,000 | Ashford | 250,000 |
| Weston-super-Mare(2nd) | 350,000 | Ostend (2nd) | 200,000 | Crefeld, Germany | 500,000 |
| Wiesbaden, Germany | 850,000 | Verviers, Belgium | 1,000,000 | Dusseldorf, Germany | 1,000,000 |
| Augsburg, Bavaria | 425,000 | Göteborg, Sweden (2nd) | 600,000 | Brussels-Koekelberg | 1,000,000 |
| Budapest (2nd) | 1,750,000 | Forst, Brandenburg | 300,000 | South Shields | 650,000 |
| Norwich (2nd) | 300,000 | Nictheroy, Brazil | 250,000 | | |

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**LICENCES granted to the above for** MANUFACTURE AND SALE of PATENT GRID of proved efficiency.
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Apply to FIRTH BLAKELEY COMPANY, Thornhill, DEWSBURY.

**STATION Meter for Sale, in very good** Condition, Was thoroughly Overhauled and Repaired by the Makers Five years ago. Capable of passing 4000 feet per hour. Six-inch Valves and Connections, with Cradle complete.
Apply to the MANAGER, Gas-Works, Old Whittington, near CHESTERFIELD.

**THE Hastings and St. Leonards Gas** Company have FOR SALE, consequent upon the removal of the Carbonizing Plant to the new Glyne Gap Works, near Bexhill, the following:
30,000 cubic feet per hour STATION METER.
50,000 cubic feet per hour ENGINE AND EXHAUSTER.
30 feet square and 20 feet square PURIFIERS, with Lifting Gear.
SCRUBBERS and WASHERS.
ENGINES and BOILERS.
HYDRAULIC MAINS, Patent MOUTHPIECES and ASCENSION PIPES, &c.
Retort-House ROOFS, and a variety of other GAS-WORKS PLANT.
Also about 3 acres of VALUABLE FREEHOLD BUILDING LAND in the centre of the Town of Hastings.
For Particulars and to view apply to CHAS. E. BOTLEY, M.Inst.C.E., Engineer and General Manager, Gas Company's Offices, Queen's Road, HASTINGS.

**BOROUGH OF LONGTON.**

TENDERS FOR GAS COAL.

**THE Gas and Electricity Committee** invite TENDERS for the Supply of 12,000 Tons of GAS COAL, Burgy, Nuts, or Beans.
Specification and Form of Tender may be obtained on Application to the undersigned.
Tenders, endorsed "Tender for Gas Coal," to be sent in, addressed to the Chairman of the Gas and Electricity Committee, not later than July 2, 1907.
W. LANGFORD.
Engineer and General Manager.
Gas and Electricity Works,
Longton.

**BOROUGH OF LONGTON.**

TENDERS FOR TAR.

**THE Gas and Electricity Committee** invite TENDERS for the Surplus TAR produced at their Works during the Year ending June 30, 1908.
Further Particulars may be obtained on Application to the undersigned.
Tenders, endorsed "Tender for Tar," to be sent in addressed to the Chairman of the Gas and Electricity Committee not later than July 2, 1907.
W. LANGFORD,
Engineer and General Manager.
Gas and Electricity Works,
Longton.

**COUNTY BOROUGH OF ROTHERHAM.**

**THE Corporation of Rotherham are** prepared to receive OFFERS for the Purchase of the Surplus GAS TAR and AMMONIACAL LIQUOR produced at their Gas-Works during the ensuing Year.
Forms of Tender and Specification may be obtained on Application to the Gas Engineer.
Offers, endorsed "Gas Tar and Ammoniacal Liquor," to be sent to me not later than the 10th of July next.
W. J. BOARD,
Town Clerk.
Town Hall, Rotherham,
June 17, 1907.

**COUNTY BOROUGH OF ROTHERHAM.**

**THE Corporation invite Tenders for the** Supply and Delivery at the Gas-Works, Frederick Street, Rotherham, of 22,000 Tons of COAL and NUTS suitable for Gas Manufacturing purposes.
Specification and Form of Tender can be obtained on Application to the Gas Engineer.
Sealed Tenders to be sent to me not later than the 10th of July next, endorsed "Tender for Gas Coal."
The Firms whose Tenders are accepted will be required to enter into Contracts which will contain the fair contracts clause.
The Corporation do not bind themselves to accept the lowest or any Tender.
By order,
W. J. BOARD,
Town Clerk
Town Hall. Rotherham,
June 17, 1907.

**BARNOLDSWICK URBAN DISTRICT COUNCIL.**
(GAS AND WATER DEPARTMENT.)

**THE above Council invite Tenders for** the Supply of 5000 Tons of GAS COAL for the Year ending June 30, 1908.
Tenders to be sent in on or before Saturday, July 6, 1907.
Particulars and Form of Tender may be obtained from the undersigned.
J. W. THOMPSON.
Engineer and Manager.
Town Hall, Barnoldswick,
Yorkshire.

**URBAN DISTRICT COUNCIL OF ROTHWELL.**
(GAS DEPARTMENT.)

**THE above Council invite Tenders for** the Purchase of their AMMONIACAL LIQUOR during the Twelve Months ending June 30, 1908.
Tenders, endorsed "Liquor," to be addressed and sent to me on or before Tuesday, July 9, 1907,
The lowest or any Tender not necessarily accepted.
WILLIAM TOZER,
Clerk to the Council.
Council Offices,
Rothwell (Northants).

**TENDERS FOR GAS COAL AND NUTS.**

**THE Gas Committee of the Ilkeston** Corporation invite TENDERS for the delivery at their Siding on the Midland Railway of 10,000 Tons of Screened GAS COAL or NUTS.
Sealed Tenders, on Forms to be had on application at the Gas Office, to be addressed to Wright Lissett, Esq., Town Clerk, Ilkeston, not later than July 3, 1907.
The Committee do not pledge themselves to accept the lowest or any Tender, and reserve their right to divide the quantity.
F. C. HUMPHRYS,
Engineer and Manager.
Gas Office, Ilkeston,
June 22, 1907.

**LINCOLN CORPORATION.**
(GAS DEPARTMENT.)

TENDERS FOR COAL.

**THE Gas Committee of the Lincoln** Corporation invite TENDERS for the Supply of 25,000 Tons of Screened or Unscreened GAS COALS and NUTS to be delivered during a period commencing the 1st of August, 1907, and terminating the 31st of July, 1908.
Further Particulars and Forms of Tender may be obtained from the undersigned.
Sealed and endorsed Tenders, addressed to the Chairman of the Gas Committee, must be delivered on or before the 15th of July next.
The Committee do not bind themselves to accept the lowest or any Tender.
JNO. CARTER,
Manager.
Gas Offices, Lincoln,
June 20, 1907.

**TEIGNMOUTH URBAN DISTRICT COUNCIL.**

**THE Gas Department of the above** Council invite TENDERS for the Supply of 4000 Tons of best Durham or other Good GAS COAL, Screened or Unscreened. Same to be supplied to the requirements of the Council between the 31st day of July, 1907, and the 30th day of June, 1908. The Coal must be Fresh-Wrought and free from all Impurities.
No Special Tender Form will be issued.
Tenders must be accompanied by a full Description and practical working Analysis of the Coals quoted, and may be f.o.b., c.i.f., Teignmouth Harbour, or f.o.r. Teignmouth Railway Station.
Sealed Tenders, endorsed "Gas Coals," to be addressed to A. Percival Dell, Esq., Clerk to the Council, Town Hall, Teignmouth, and delivered not later than Monday, the 1st day of July, 1907.
The Committee do not bind themselves to accept the lowest or any Tender.
By order,
J. ALEX. GRAY,
Gas Manager.
Gas-Works, Teignmouth,
June 11, 1907.

**COUNTY BOROUGH OF SALFORD.**
(GAS DEPARTMENT.)

GENERAL STORES.

**THE Gas Committee invite Tenders for** the following MATERIAL, in such quantities as may be required during the Twelve Months ending the 31st of August, 1908.
1.—Gas Meters.
2.—Iron and Steel.
3.—Cast-Iron Main Pipes and Connections.
4.—Iron Castings.
5.—Gas and Steam Tubing and Sundry Fittings.
6.—Gun Metal Meter Taps and Keys, Pillar and Bracket Taps.
7.—Brass Fittings for Meters.
8.—Lead Pipe, Block Tin Tubing and Pendants.
9.—Ropes, Tarred and Spun Yarn and Twine.
10.—Oils and Tallow.
11.—Paints.
12.—Brushes.
13.—India-Rubber Tubing, Sheeting, &c.
14.—Timber.
15.—Testing and Repairing of Weighing Machines.
Forms of Tender and all Information may be obtained and Samples seen on application to Mr. William W. Woodward, Engineer, Gas Offices, Bloom Street, Salford.
Sealed Tenders, endorsed "Tender for Stores," addressed to the Chairman of the Gas Committee, Town Hall, Salford, to be delivered to me not later than Three p.m. on Thursday, the 4th of July, 1907.
L. C. EVANS,
Town Clerk.
Town Hall, Salford,
June 20, 1907.

**SOUTH OXFORDSHIRE WATER AND GAS COMPANY.**

STEAM AND GAS COAL.

**THE Directors of this Company are** prepared to receive TENDERS for the Supply of all or part of 1000 Tons of SMOKELESS STEAM COAL and 700 Tons of GAS COAL in quantities from time to time as required for the Twelve Months ending June 30, 1908.
Tenders, for which no Special Form is required, accompanied by full Description and to cover free delivery to Goring-on-Thames Station, Great Western Railway, to be sent to me not later than July 3, 1907.
By order,
F. C. ROBUS, F.C.I.S.,
Secretary.
2 & 3, Norfolk Street, Strand, W.C.,
June 20, 1907.

**LONDON COUNTY ASYLUM, HANWELL, W.**

**THE Sub-Committee for the Control and** Management of the above-named Asylum are prepared to receive OFFERS for the Purchase of TAR and AMMONIACAL LIQUOR for the Twelve Months ending June 30, 1908.
Terms, Cash on Removal.
Forms of Tender, with Estimated Quantities for sale, may be obtained on Application to the Resident Engineer at the Asylum.
Tenders, in sealed covers, endorsed "Tender for Tar and Liquor, Hanwell Asylum," must be sent to the undersigned by or before Ten o'clock a.m. on Saturday, the 29th of June, 1907.
The Sub-Committee do not bind themselves to accep the highest or any Tender.
H. F. KEENE,
Clerk of the Asylums Committee.
London Asylums Committee Office,
6, Waterloo Place, S.W.
June 18, 1907.

**EXMOUTH GAS COMPANY.**

**THE Directors of the Exmouth Gas** Company invite TENDERS for the Supply of 5000 Tons of Best GAS COAL (Screened or Unscreened), to be delivered in such quantities and at such times as may be required from the 1st of August, 1907, to the 31st of August, 1908, and to weigh 20 cwt. to the Ton over the Gas Company's or Dock Company's Weighbridge, the Coal to be Fresh Wrought, Dry, and free from Hards, Smudge, Shale, and Pyrites.
Tenders to be accompanied by Practical Working Analysis.
Prices may be quoted c.i.f. or f.o.b. Exmouth Docks, or f.o.r. Exmouth Railway Station (L. & S.W. Rly.).
Sealed Tenders, endorsed "Tender for Coal," to be sent to the undersigned not later than Saturday, the 29th day of June, 1907.
The Directors do not bind themselves to accept the lowest or any Tender.
Special Tender Forms are not provided or required.
JAMES T. FOSTER,
Secretary and Manager.
Gas-Works, Exmouth,
June 4, 1907.

**CITY OF COVENTRY.**

REFUSE DESTRUCTOR, BOILER PLANT, &c.

**THE General Works Committee of the** Coventry Corporation invite SCHEMES and TENDERS for the works required to be executed, and Materials supplied, in the Erection of a REFUSE DESTRUCTOR, BOILER PLANT, &c., on a site at Bishopgate Green, Foleshill Road, Coventry.
Particulars and Plan of Site may be obtained from the undersigned on and after Monday, the 17th of June, 1907, on payment of £5 to the City Treasurer, which will be returned on receipt of a *bona-fide* Tender.
Sealed Tenders, &c., endorsed "Refuse Destructor, &c.," to be delivered at the Office of the Town Clerk, 10, Hay Lane, Coventry, not later than Monday, the 8th of July, 1907.
The lowest or any Tender will not necessarily be accepted.
No Tender will be considered which is not made out on the Form supplied, and no allowance will be made to the persons tendering.
J. E. SWINDLEHURST, M.Inst.C.E.,
City Engineer and Surveyor.
St. Mary's Hall,
June 10, 1907.

**URBAN DISTRICT COUNCIL OF WINSFORD.**

**THE above Council are prepared to** receive TENDERS for the Supply of CANNEL and best Screened GAS COAL, to be delivered at the Cheshire Lines Station, Winsford, or the Over and Wharton Station of the L. & N.W. Rly., or at the Council's Wharf on the River Weaver at Winsford. The material is required for a term of Twelve Months ending the 1st of August, 1908.
The probable quantities required will be about 400 Tons of Cannel and about 1700 Tons of Gas Coal, which must be freshly wrought, well screened, and free from Sulphurous Pyrites and other objectionable matter; but the Council reserve the right of reasonably increasing or decreasing the quantities named. The person whose Tender is accepted will be required to enter into an agreement with the Council for the due performance of the Contract.
Sealed Tenders, stating price per Ton delivered as above, are to be received by the undersigned on or before the 9th of July, 1907, and endorsed "Gas Coal Tender."
The Council do not bind themselves to accept the lowest or any Tender.
Forms of Tender and further Particulars may be had on Application to the Gas Manager, F. Sidwell, Winsford, or from
JNO. H. COOKE,
Clerk to the Council.
Council Offices, Russell Street
Winsford, Cheshire.
June 20, 1907.

### SAFFRON WALDEN UNION.

TENDERS FOR COAL AND COKE.

**THE Guardians of the above Union are** prepared to receive TENDERS for the Supply of about 250 Tons of Best Hand-Picked Hard STEAM COAL and 20 Tons of COKE for Twelve Months, to be delivered at the Saffron Walden Railway Station each Month as required.

Sealed Tenders, endorsed "Tender for Coal," to be sent to me, the undersigned, not later than Monday, the 1st day of July next.

The lowest Tender will not necessarily be accepted.

By order,
H. COBDEN,
Clerk.

Saffron Walden,
June 19, 1907.

### TENDERS FOR TAR.

**THE Directors of the Altrincham Gas** Company invite TENDERS for the Surplus TAR produced at their Works between the 1st of July next and the 30th of June, 1908.

Estimated quantity, 1050 Tons.

Delivery, at the option of the Gas Company, into Contractors or Gas Company's Tank-Waggons at Altrincham Station, or in Contractor's Barrel Carts at the Gas-Works, and separate Prices should be given in each case.

Sealed Tenders, addressed to the Chairman, and endorsed "Tender for Tar," to be delivered not later than noon on Tuesday, July 9.

J. E. LAMB,
Manager.

Gas Offices, Altrincham,
June 19, 1907.

### HORNSEY GAS COMPANY.

**NOTICE is Hereby Given, that the** TRANSFER BOOKS of this Company relating to DEBENTURE STOCK ONLY WILL BE CLOSED on the 21st inst., and RE-OPENED on the 1st of July, 1907.

By order of the Board,
WILLIAM E. ROBERTS,
Secretary.

63, Chancery Lane, W.C.,
June 20, 1907.

### THE GASLIGHT AND COKE COMPANY.

**NOTICE is Hereby Given, that the** TRANSFER BOOKS of this Company, so far as they relate TO CAPITAL STOCKS, WILL BE CLOSED at 4 o'clock p.m., on Tuesday, the 2nd day of July next, and will be re-opened immediately after the HALF-YEARLY ORDINARY GENERAL MEETING of the Company to be held on Friday, the 2nd day of August next.

By order,
HENRY RAYNER,
Secretary.

Chief Office: Horseferry Road,
Westminster, S.W., June 20, 1907.

### IN THE HIGH COURT OF JUSTICE.

COMPANIES (WINDING UP.) No. 00416 OF 1906.

IN THE MATTER OF THE KENT COUNTY GASLIGHT AND COKE COMPANY, LIMITED.

(IN LIQUIDATION.)

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**MR. ALFRED RICHARDS begs to** notify that his ISSUES by AUCTION under PARLIAMENTARY POWERS of STOCKS and SHARES in LONDON, SUBURBAN, and PROVINCIAL GAS and WATER COMPANIES take place PERIODICALLY at the Mart, TOKENHOUSE YARD, E.C.

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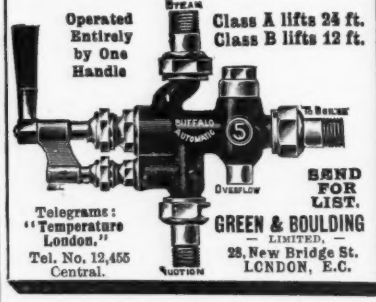

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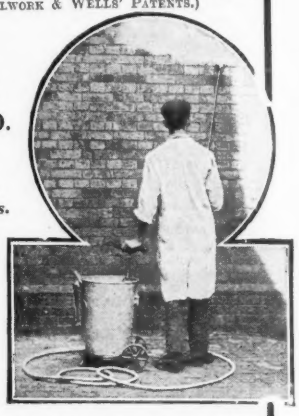
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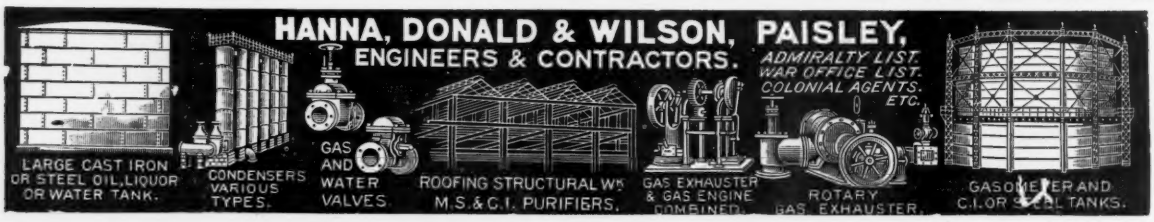


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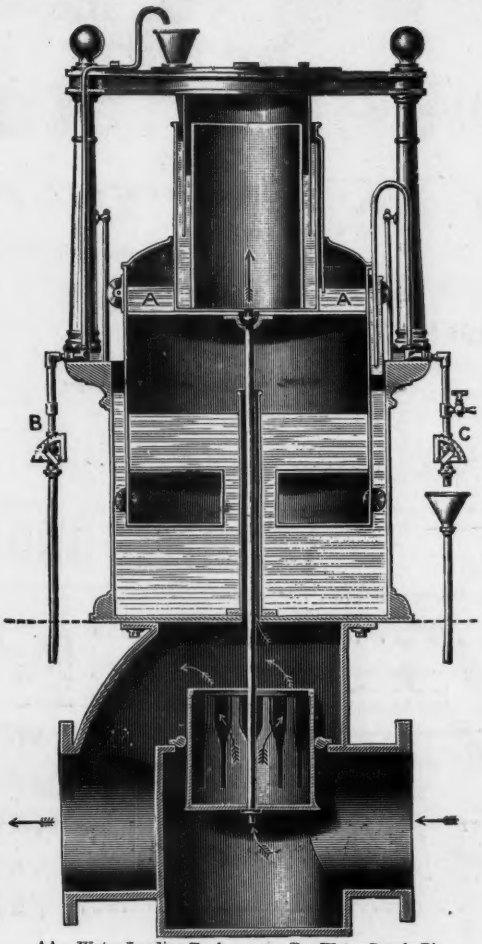


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